

IN PREHISTORIC SEAS

CARROLL LANE FENTON and MILDRED ADAMS FENTON



PRICE, 50¢

IN PREHISTORIC SEAS

*by Carroll Lane Fenton
and Mildred Adams Fenton
illustrated with drawings
by Carroll Lane Fenton
and with photographs*

Long, long ago, when places that are now dry land were covered by salt seas, a fascinating array of creatures lived in these waters, died, and left remains that can be found and identified today.

IN PREHISTORIC SEAS provides an introduction to these ancient creatures, beginning on a modern shore where readers can pick up shells relating to them. A survey of early seas and past ages follows, with a review of fossils ranging from simple "forams" and sponges to whales. To help young fossil hunters identify their finds, the names of the fossils are given with their pictures, and the geologic age of the species is indicated in parenthesis.

Known for their many contributions to the study of natural history, the Fentons are the authors of popular books about living plants and animals, as well as fossils and rocks. The clear text and profuse illustrations of IN PREHISTORIC SEAS make this book an invaluable guide to understanding the sea and its mysteries for readers of any age.

A companion book to
PREHISTORIC ZOO

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IN PREHISTORIC SEAS

When prehistoric animals are mentioned, we often think of dinosaurs and mammoths. These, however, are only a few of the creatures that lived during past ages—a few that never left the land. A vastly greater array of animals lived and died in prehistoric seas.

In Prehistoric Seas provides an introduction to the inhabitants of long-vanished seas. This introduction begins on a modern shore, where we may pick up shells related to ancient creatures. Next comes a survey of early seas and past ages. This is followed by a review of fossils that range from simple “forams” and sponges to whales.

This review is not technical; most of its words are already familiar to third- and fourth-grade readers. But many young people will do more than read; they will collect fossil corals, lamp-shells, snails, horn-shells, trilobites, and so on. Any book that describes and illustrates fossils should help these young collectors name, or identify, their specimens. In order to meet this need, the names of fossils are given with their pictures. Words in parenthesis also tell the geologic age of species that are illustrated. Since most names of fossils and ages are unfamiliar, the reasons for their use are explained on pages 124–125.

The Fentons are widely known for their books about fossils and rocks, as well as living plants and animals. They have illustrated *In Prehistoric Seas* with forty-five of Mrs. Fenton's photographs and more than 200 of her husband's drawings, many of which first appeared in *The Fossil Book*. Forty additional drawings have been taken from the works of other scientists.

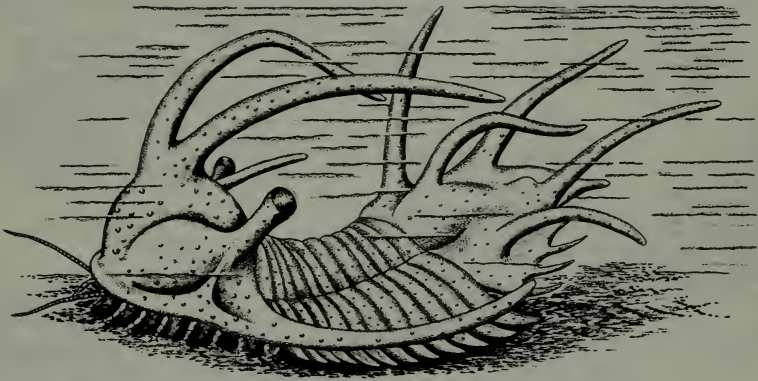
By Carroll Lane Fenton and Mildred Adams Fenton

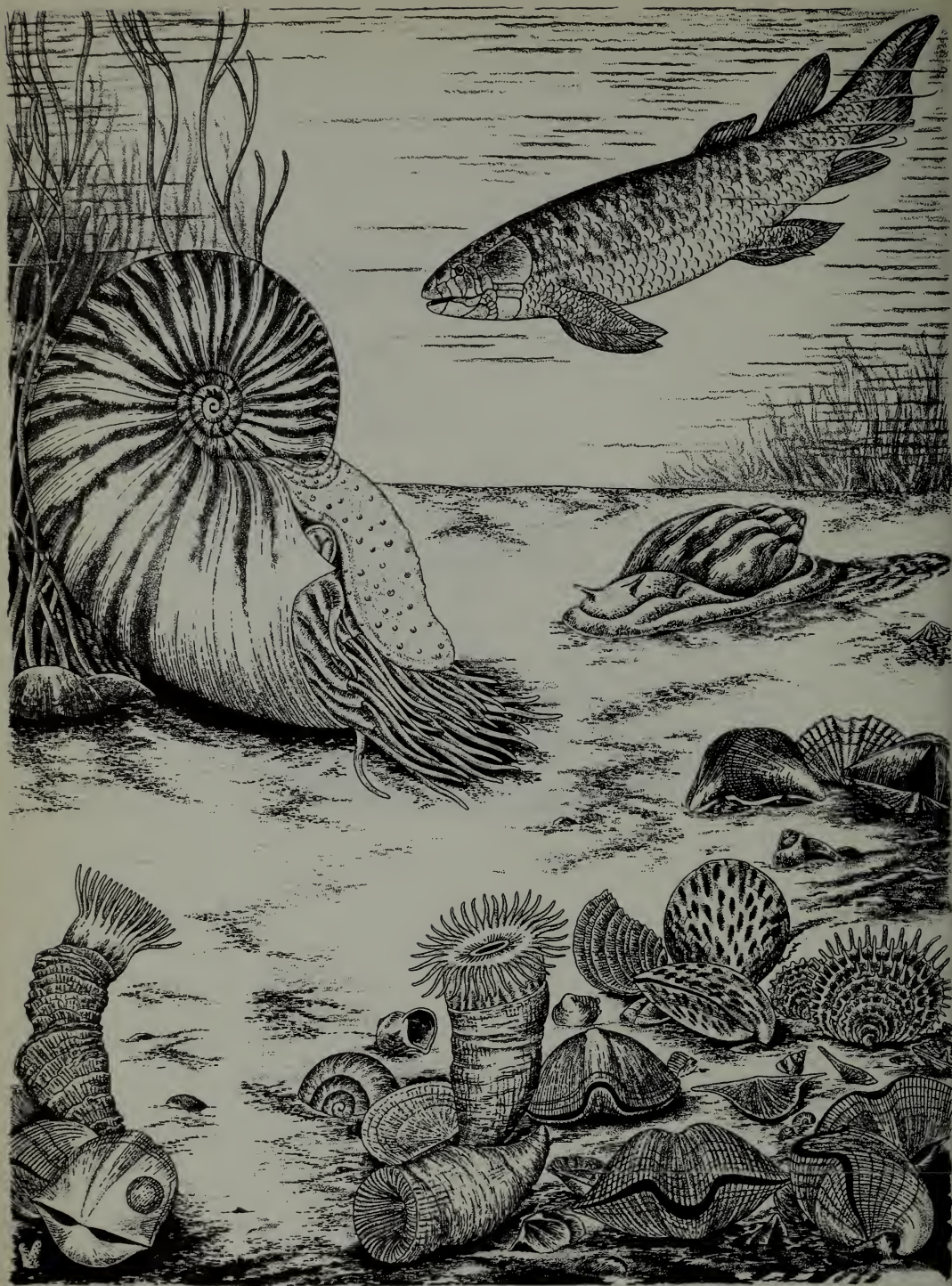
GIANTS OF GEOLOGY
IN PREHISTORIC SEAS
THE LAND WE LIVE ON
OUR CHANGING WEATHER
PREHISTORIC ZOO
THE ROCK BOOK
ROCKS AND THEIR STORIES
THE FOSSIL BOOK

By Carroll Lane Fenton

OUR AMAZING EARTH
OUR LIVING WORLD

IN PREHISTORIC
SEAS





These creatures lived in a sea that spread from the Arctic Ocean to Iowa late in the Devonian Age.

IN PREHISTORIC SEAS

Carroll Lane Fenton *and*
Mildred Adams Fenton

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All drawings on page 47 are taken from Volume 8 of the Palaeontology of New York. Drawings on page 57, and all except the lowermost three drawings on page 59 come from Monograph 54 of the U. S. Geological Survey.



Library of Congress Catalog Card Number 63-8771
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First Edition

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IN PREHISTORIC
SEAS



Waves washed these shells ashore and left them on a beach.

SHELLS ON THE SEASHORE

When we go to the seashore we often find shells which waves have left on the sand.

Some shells may once have belonged to oysters, but others came from dark-colored mussels or from clams of various kinds.

There are mud-snails and rock snails, too, as well as plump, smooth moon snails and rough grayish-white whelks.

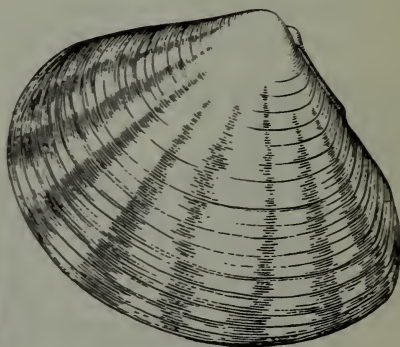
A crab's claw may lie among the snails, and so may a white sand dollar whose shell is flat on the underside.

All these creatures live in the salty sea water
or burrow in sand and mud on the bottom.
When the animals die, their shells roll about
and are washed ashore by waves.
The empty shells would tell us we are near the sea
even if we did not look at the water
or hear the waves as they roll and splash
on rocks and on the sandy beach.

If you find some of these shells on the shore, you may be sure they
belong to creatures that lived in the sea.



"Claw" of a crab



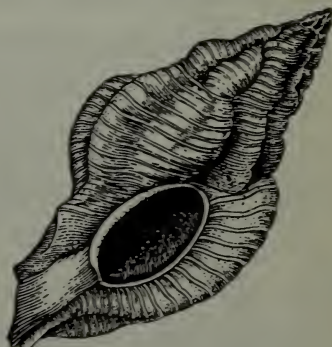
Pismo clam



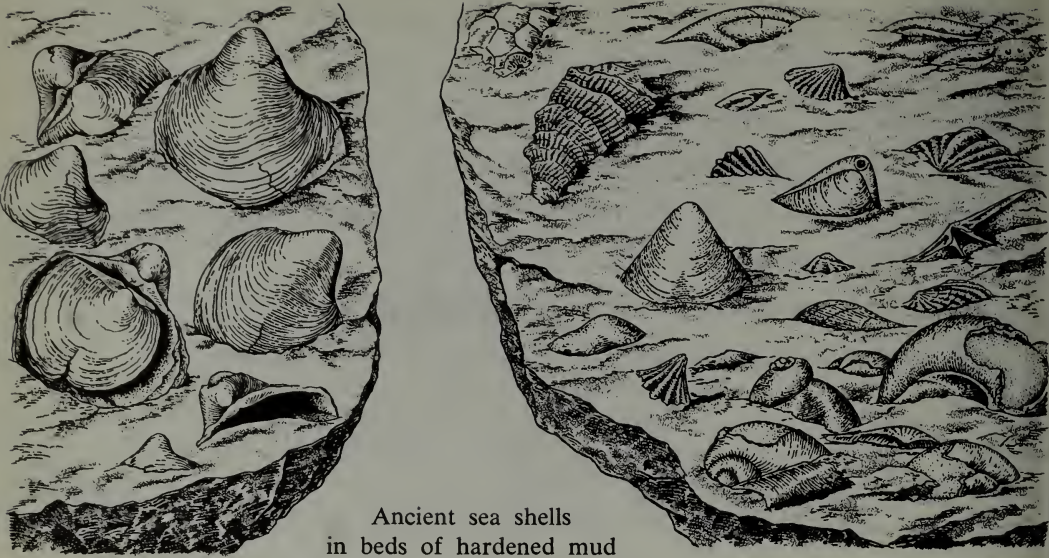
Channel whelk



Moon snail



Rock snail



Ancient sea shells
in beds of hardened mud

ANCIENT SEA SHELLS

The shells we now find on beaches
come from the sea that is not far away.

But sea shells may also be found on land,
dozens or many hundreds of miles
from the nearest bay or ocean.

These shells belonged to creatures
that lived during very ancient ages
when places that are now dry land
sank . . . and sank . . . and sank till salt water
flowed over them and formed shallow seas.

When creatures that lived in those old seas died,
their shells often lay on the sea bottom
until they were covered with sand or fine mud.

In time the layers of mud and sand became rocks that were pushed upward until they formed land. We see some of these rocks beside rivers and roads, as well as in stone quarries, on hillsides and on high, barren mountains. In these places many beds of rock still contain shells and other remains of the creatures that lived, died, and then were covered with sand or mud that settled in ancient seas.

These beds of rock settled on the bottom of an ancient sea but were pushed up into land. One slab shows several shells.



SOME "PREHISTORIC" SEAS

The maps on pages 15 and 17 show North America during two of the ages when salty sea water covered many regions that are now land.

Below the maps are shells of several creatures that lived in those long-vanished seas.

We often say these shells are "prehistoric," but we also call them "fossils"

and say that they have been "petrified."

"Prehistoric" means that the creatures lived long before people learned to write

or to carve names, dates, and stories on stone.

"Fossils" tells us that prehistoric creatures

left shells, bones, teeth, impressions,

or even burrows in beds of sand or sticky mud which slowly turned into rock.

"Petrified" means that some prehistoric fossils have become stony material

which may be crumbly or easily broken,

or may be harder and stronger than glass.

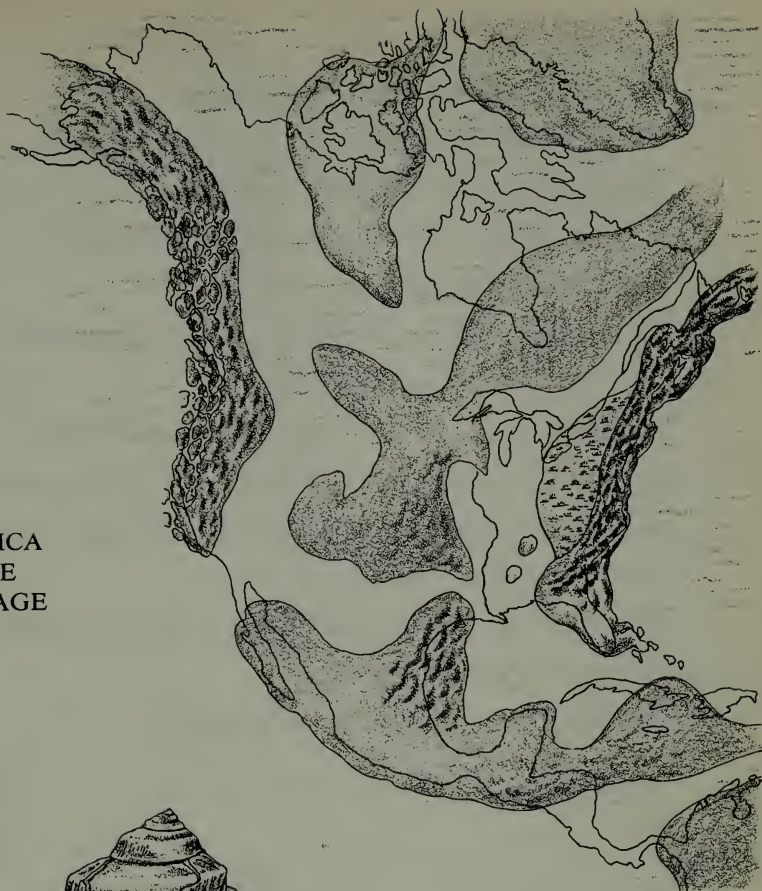
Some petrified fossils keep their colors

and resemble shells freshly washed onto seashores.

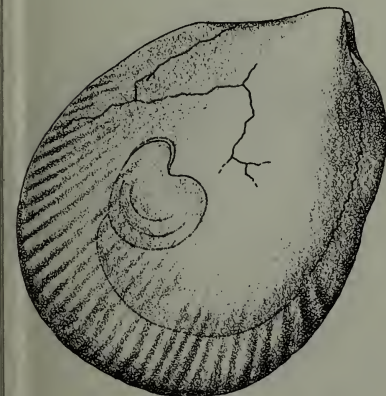
Other petrified shells shine like pearls

or have been colored brown, yellow, or brick red

NORTH AMERICA
LATE IN THE
ORDOVICIAN AGE



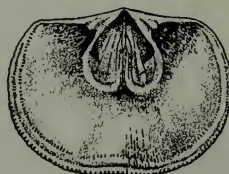
Snails



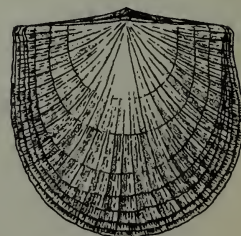
Mussel



Sea lily, or crinoid



Lamp-shells,
or brachiopods



Land (dark) and seas (wavy lines) of North America about 400 million years ago. Pictures show some of the animals that lived in these seas.

by the minerals which make them stony.
Most petrified shells, however, are colored
like the rocks in which we find them.
So are fossils like the mussel on page 15
and some of the clams on page 23.
These fossils are made of mud that filled shells
and then hardened into stone
while the shells broke to pieces or crumbled.
Such fossils are called internal, or inside, molds,
while impressions made by the outsides of shells
are external, or outside, molds.
You can see both external and internal molds
in the two slabs of stone
that are shown at the top of page 22.

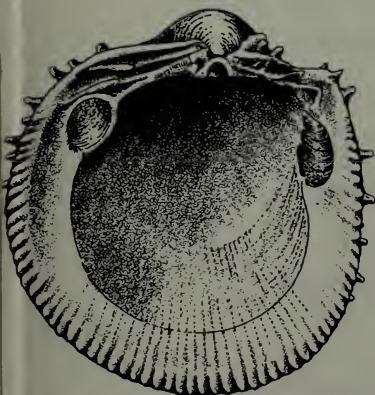
NORTH AMERICA
LATE IN THE
CRETACEOUS AGE



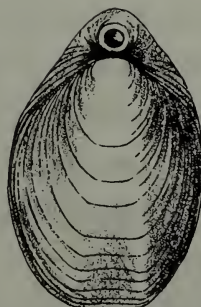
Snail



Coral



Cockle



Lamp-shell, or brachiopod



Snail

Land (dark) and seas (wavy lines) of North America about eighty million years ago. Below the map are some typical fossils.

HOW OLD ARE THEY?

When we say that fossils are “prehistoric” we do not mean that they lived at one time. Some fossils lived a few thousand years ago—long after human beings began to dwell in caves and make tools or weapons of stone. Other fossils lived many millions of years before human beings came into existence. We divide the story of the earth and of fossils into eras, periods (or ages), and epochs, just as we divide the long story of human beings into the Stone Age, the Bronze Age, and so on. The eras, ages, and epochs have been given names. You will find most of these names in the Calendar of Ancient Ages on pages 20–21. This calendar should be read from bottom to top, for it begins with the earliest, or oldest, era and ends with the epoch in which we are living. Column 1 in the Calendar names the eras. Column 2 lists twelve ages, or periods, as well as epochs which make up the two ages in the Cenozoic Era. Column 3 tells about how many years have passed since each age or epoch began.

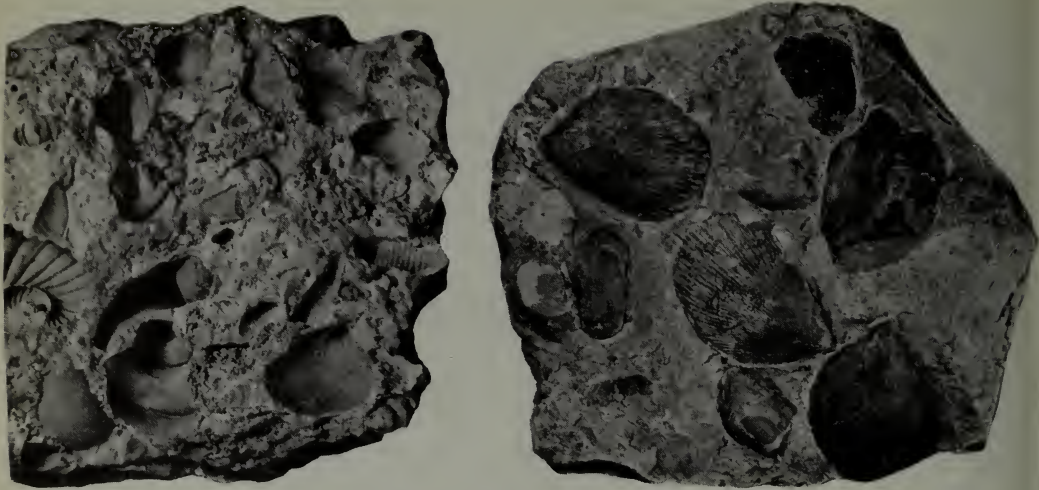
Column 4 lists some of the things that happened to the earth and to plants and animals. If you want to know how old some fossil is, first notice the name of its age or epoch, which is printed like this: (*Silurian*). Then find this name in Column 2 on page 20 or 21. Column 3 will tell when this age or epoch began, and when it ended and was followed by a new one. The fossil lived sometime between those two dates. A Silurian clam or snail, for example, lived between 430 and 405 million years ago when this particular age began and when it came to an end. If the fossil was found in Middle Silurian rocks it may be 415 to 420 million years old.

CALENDAR OF ANCIENT AGES

1. Eras	2. Ages, or Periods, and Epochs	3. When They Began	4. Changes in Lands, Seas, and Living Things
CENOZOIC <i>or Era of Mammals</i>	Quaternary Age	8,000 TO 10,000 YEARS AGO	Great glaciers finally melted and climates grew warm. Many large land mammals died out; marine animals began to live in their present homes.
	PLEISTOCENE EPOCH OFTEN CALLED THE ICE AGE	ABOUT ONE MILLION YEARS AGO	Glaciers repeatedly spread over much of Europe, Asia, and North America. Climates and seas were cold when glaciers were large. Northern clams, snails, and other sea-dwelling animals lived near southern shores.
	PLIOCENE EPOCH	12 MILLION	High mountains formed when this period, or age, began and several times while it lasted. Seas seldom covered much of the continents. Mammals became common on land. Sharks and bony fish became plentiful; some sharks were very large. Modern types of corals developed; ammonoids and belemnoids disappeared; clams and snails became more and more like kinds that are living today. Some even belonged to the same species.
	MIOCENE EPOCH	25.7 MILLION	
	OLIGOCENE EPOCH	34 MILLION	
	EOCENE EPOCH	55 MILLION	
	PALEOCENE EPOCH	70 MILLION YEARS AGO	Lands remained low, climates were mild, and dinosaurs were common. Seas spread widely; ammonoids, belemnoids, and relatives of oysters were plentiful. So were turtles, fish-lizards, and other marine reptiles.
MESOZOIC <i>or Era of Reptiles</i>	CRETACEOUS AGE	135 MILLION YEARS AGO	Lands were low; shallow seas covered much of Europe; there were deserts, volcanoes, and swampy forests in western North America. Ammonoids, belemnoids, and marine reptiles were common; dinosaurs became very large.
	JURASSIC AGE	180 MILLION YEARS AGO	Seas covered much of Europe. Ammonoids became common. Fish-lizards and early plesiosaurs were plentiful, and many other reptiles appeared. The first dinosaurs became common, but they were not very large.
	TRIASSIC AGE	220 MILLION YEARS AGO	

PALEOZOIC or Era of Ancient Animals			
PERMIAN AGE	Carboniferous Ages	PENNSYLVANIAN AGE	270 MILLION YEARS AGO
		MISSISSIPPIAN AGE	310 MILLION YEARS AGO
		DEVONIAN AGE	350 MILLION YEARS AGO
		SILURIAN AGE	405 MILLION YEARS AGO
ORDOVICIAN AGE			430 MILLION YEARS AGO
			490 MILLION YEARS AGO
			570 MILLION YEARS AGO
PRECAMBRIAN ERAS		AT LEAST 3,300 MILLION YEARS AGO	

Coal swamps still existed. Big amphibians and strange reptiles lived in moist forests. Sharklike fish as well as lamp-shells, sponges, and early ammonoids lived in seas that spread into the Southwest, Europe, and Asia.	Coal formed in great swamps; seas spread but did not last long. Reptiles and amphibians became good-sized. Mountains formed near the end of this age. Sea lilies and their relatives became much less abundant.
Seas covered much of North America, especially early in this age. Sea lilies and blastoids were very abundant, but trilobites were rare. Moss-animals of lacy types were common, but lamp-shells were less so.	North America was low and flat; seas spread widely, though mountains began to rise late in this age. Corals, lamp-shells, trilobites, glass sponges, and other marine animals were plentiful. So were armored fish.
Europe still was mountainous, but North America was low and much of it was under the sea. Large, straight horn-shells were rare; curved and coiled kinds became common. Sea scorpions became plentiful.	Shifting seas covered more than half of North America; mountains rose in Europe. Lamp-shells, moss-animals, and trilobites became common, but most corals were small. Snails and clams belonged to very ancient types.
Most of North America was low. Animals, especially trilobites and lamp-shells, first became common fossils. Most other groups are rare.	There were many changes in lands and seas, but they took place so long ago that their order is uncertain. Few animals left recognizable fossils.

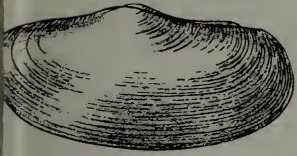


The rock at the left shows external molds of shells. At the right are internal molds of clams and of mussels with ridges on their shells, called Byssonychia. (*Late Ordovician*)

SOME VERY OLD CLAMS

Clams are common on many modern seashores. Clam shells are common fossils, too, but most of the good shells come from rocks that formed during Mesozoic and Cenozoic Ages. In older times most clams had thin shells that disappeared soon after the creatures died. This explains why many Paleozoic clams are impressions of shells (external molds) or are internal molds made of hardened mud or sand that filled shells which then disappeared.

Three internal molds are shown on this page.
 With them are five petrified clams.
 They show the outer surfaces of the shells,
 with ridges and wrinkles that were formed
 as the clams grew and made their shells larger.
 Molds show only the general shapes of the shells
 with some of the coarsest wrinkles
 and places (M) where muscles were fastened
 to close the shells and keep them shut.



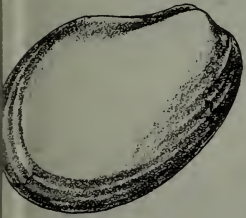
Solemya (Devonian)
 A very primitive clam



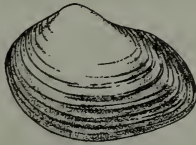
Grammysiodes (Devonian)



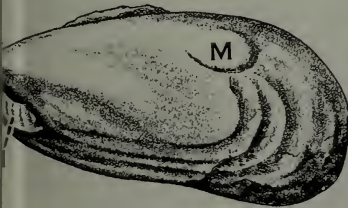
Myalina (Permian)



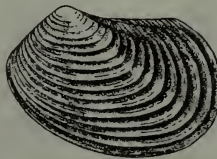
Ischyrodonta (Ordovician)
 A mold



Schizodus
(Pennsylvanian-Permian)



A mold
Ischyrodonta (Ordovician)



Grammysia
(Mississippian)



A mold
Modiolodon (Ordovician)

Several Paleozoic clams. M shows where muscles were attached.

CLAMS THAT CHANGED

The very first clams were small, smooth creatures whose thin shells were not very strong and were not held together very tightly.

Some clams of this type still live in the sea—a few resemble *Solemya*, which is shown on page 23. But as ages went by, prehistoric clams changed in many ways.

One good change was to build thick, sturdy shells which often were made still stronger by ridges.

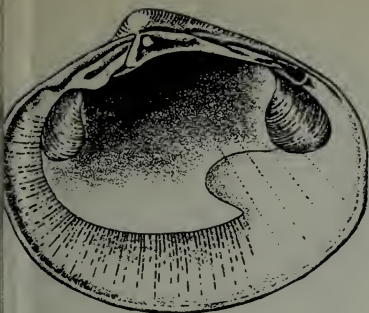
Another good change was to grow so-called teeth which fitted into deep hollows, or sockets, and so held both halves of the shell together.

Other clams became mussels with narrow shells.

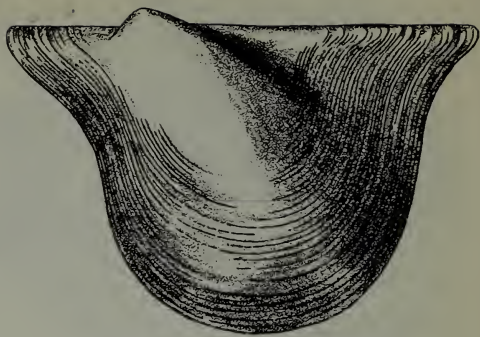
These mussels spun long, tough threads which held tightly to stones or to other shells, so waves that crashed on rocky seacoasts could not wash the creatures away.

While mussels fastened themselves to rocks other clams burrowed into sand and mud, or into logs that had sunk in bays.

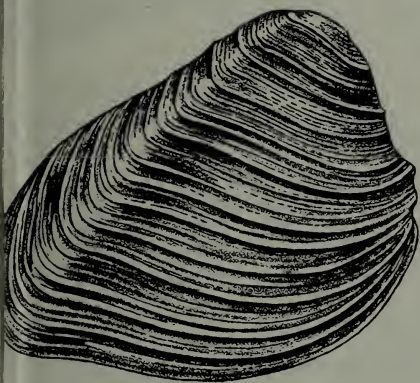
Log-borers lined their burrows with limy tubes which are sometimes found in petrified wood.



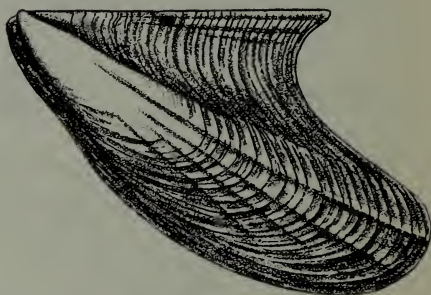
Meretrix (Late Cretaceous)



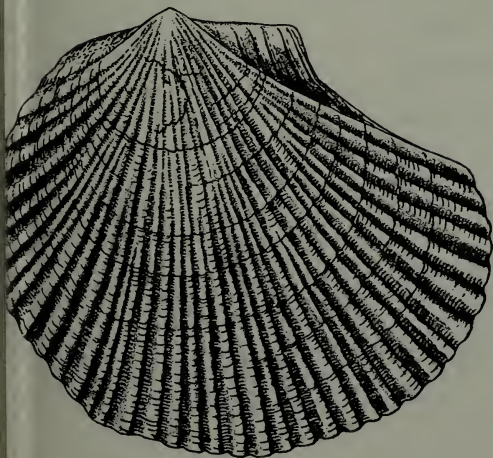
Pteria (Late Cretaceous)



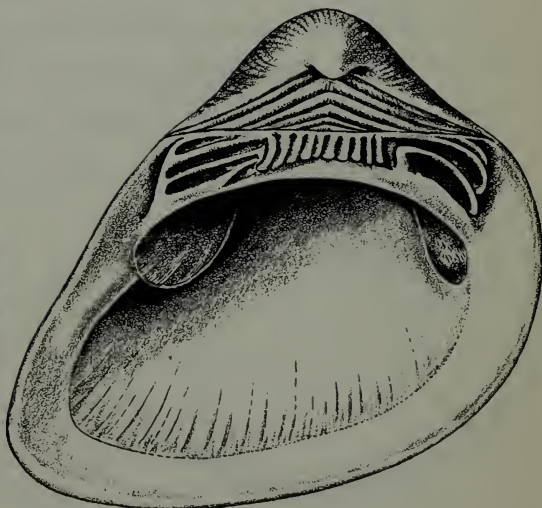
Veniella (Late Cretaceous)



Gervillia (Late Jurassic)

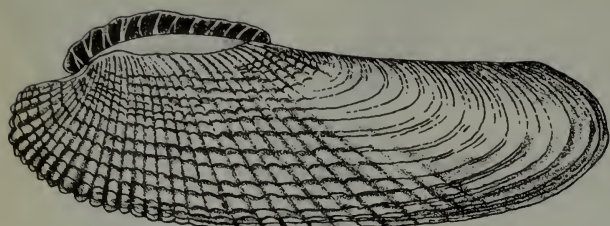


Monotis (Triassic)

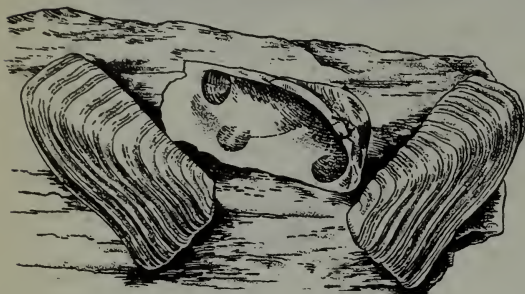


Cucullea (Cretaceous)

Some clams of Mesozoic ages.



Pholas, a burrower (*Miocene*)



Saxicava, another burrower (*Miocene-Recent*)



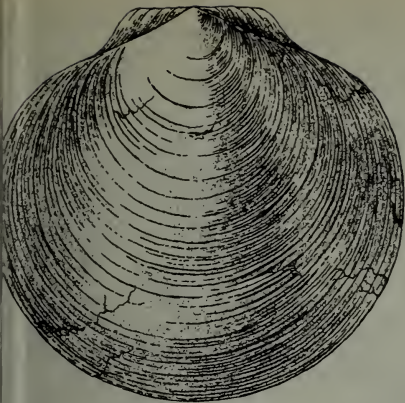
Tubes made by clams related to the so-called shipworm (*Cretaceous*)

Burrowing clams and tube-builders.

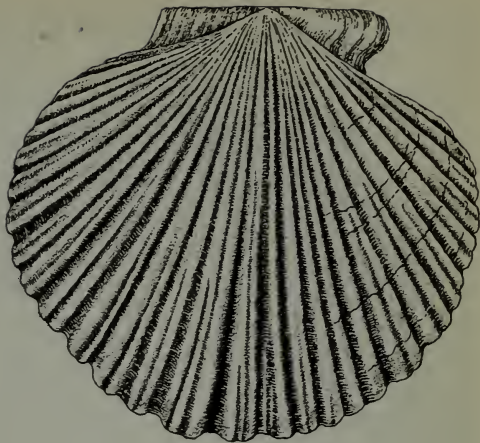
Finally, some clams became scallops, or pectens, whose broad shells were almost round.

Modern scallops swim by opening their shells and then closing them with a snap.

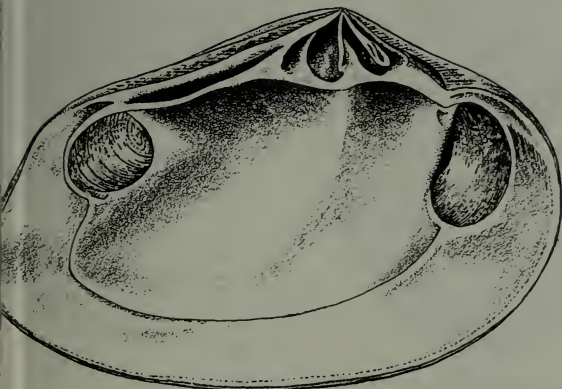
Every snap sends out a jet of water which pushes the scallop backward much faster than any clam can crawl.



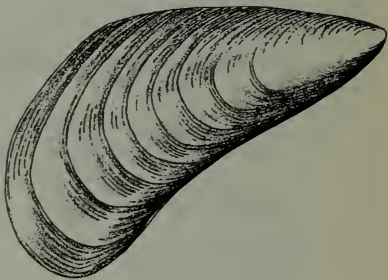
Pecten (Miocene-Pliocene)
A smooth-shelled scallop



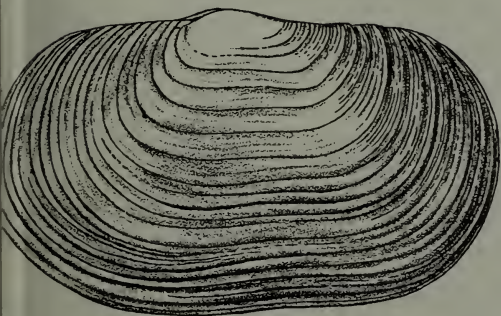
Pecten (Pliocene)
A scallop with ribs, or ridges



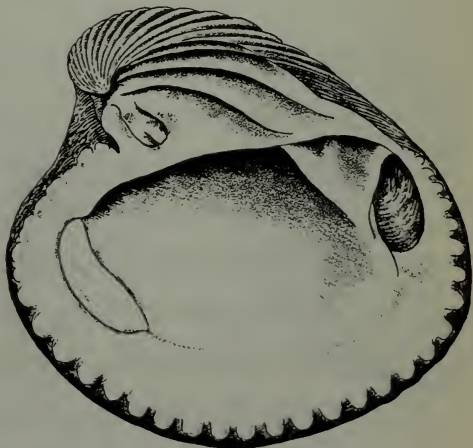
Crassatellites (Miocene)



Mytilus (Miocene)
A small mussel

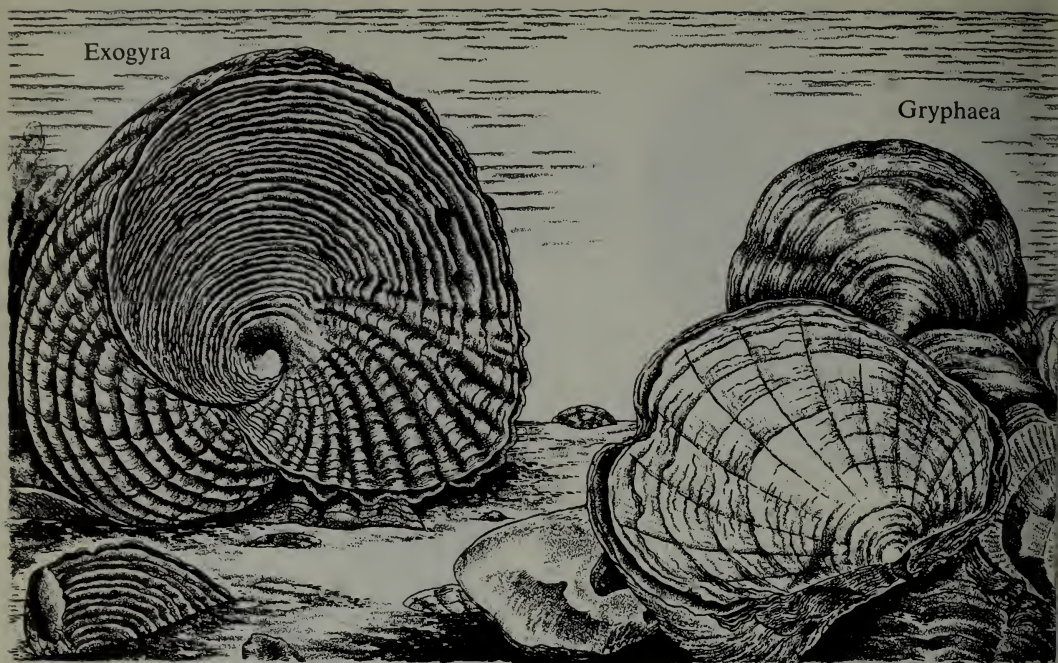


Panope (Miocene-Recent)



Venericardia (Eocene)

Some clams of the Cenozoic Era.



One of these shells is coiled, but the other has become bowl-shaped. Both kinds lived in late Cretaceous seas.

OYSTERS AND COILED SHELLS

Oysters lie on their left sides,
 which are fastened to stones or to other shells.
 Many oysters are bent and others are wrinkled,
 but some of their fossil relatives coiled.
 These creatures also lay on their left sides,
 which grew much faster than their right sides.
 Soon the left part of each shell began to coil,
 while the right-hand part became almost flat
 and opened and closed like a lid.

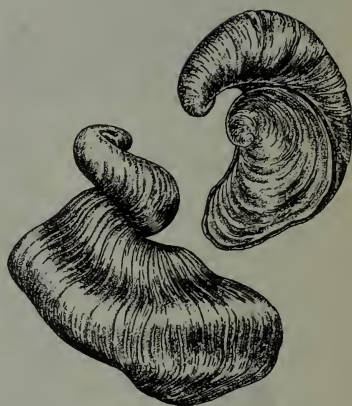
Several oysterlike creatures went still further.
 Some stopped coiling and became irregular bowls
 with covers shaped like half of a saucer.
 Both half-shells of some other kinds twisted
 till the creatures looked like two short snails
 that were fastened together near their openings
 but coiled in opposite ways.



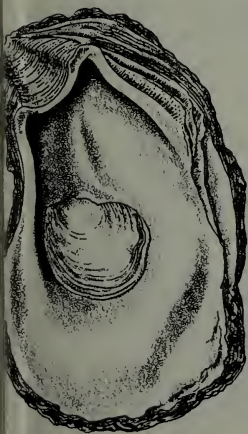
Ostrea (Cretaceous)
 A primitive oyster



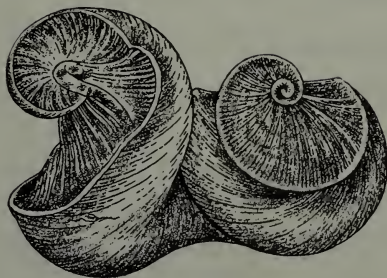
Gryphaea
 (Early Cretaceous)



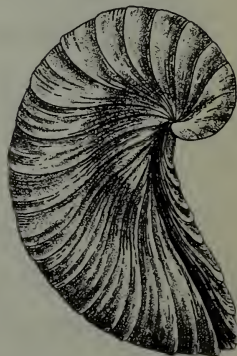
Exogyra (Late Cretaceous)
 A small twisted species



Ostrea (Miocene)
 A typical oyster



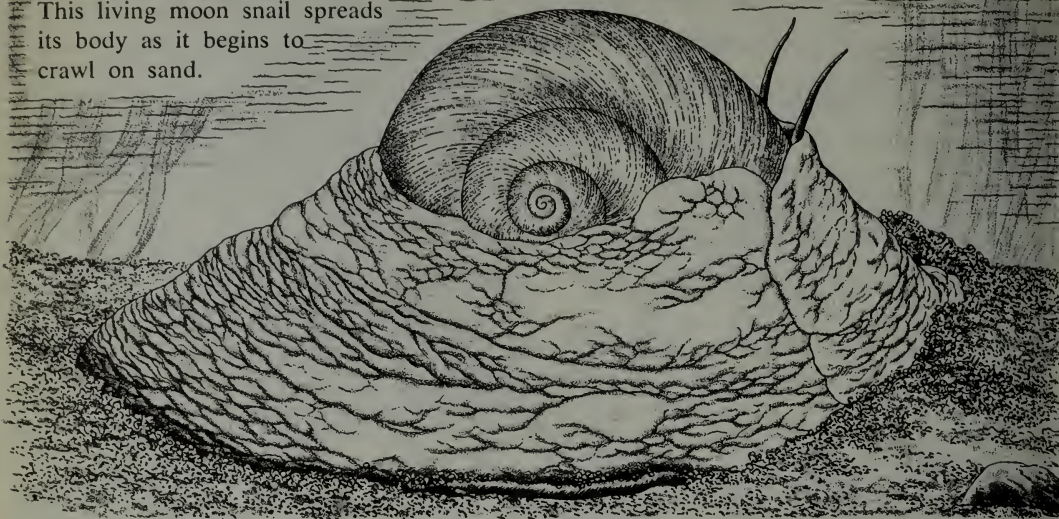
Toucasia (Early Cretaceous).
 Both halves of the shell
 are coiled.



Gryphaea (Jurassic)

Two oysters and some shells related to them.

This living moon snail spreads
its body as it begins to
crawl on sand.



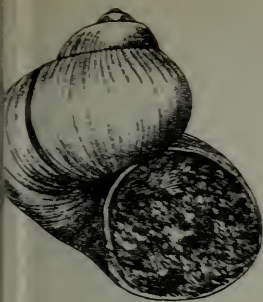
SNAILS

Clams are the commonest shells on most beaches,
but snail shells are plentiful, too.

Some are broad or look like half of a clam,
but most snail shells coil round and round,
and the soft-bodied creatures that make them
live in the largest coil, or whorl.

Some snails can swim and some use claws
to pull themselves over mud or sand.

When other snails want to travel
they pump water *into* their soft bodies,
which soon spread out of the shells.



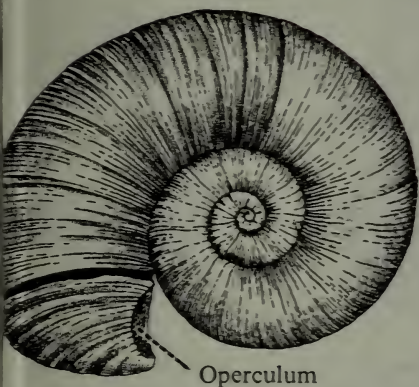
Holopea (Ordovician)



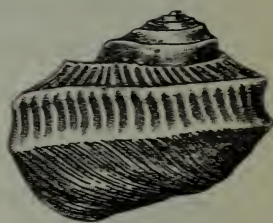
Leptotygya (Pennsylvanian)



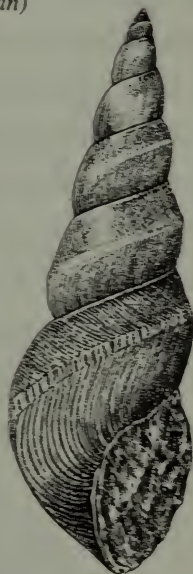
Platyceras (Silurian)



Maclurites (Ordovician). Its thick operculum still covers the opening of the shell.



Trochonema (Ordovician)



Hormotoma (Silurian)



Buccinum, a modern snail, crawling over mud.



Helminthozyga (Pennsylvanian)

Some ancient and modern snails.

Then the creatures crawl away on broad feet
which really are their soft undersides.

When a snail is alarmed, it pumps water
out of its body, and pulls back into its shell.

Snails like cone-shells, or *Conus*, (page 33) do only this,
for their shells have narrow openings.

Other snails build shells with broad openings
which must be closed with hard doors
known as opercula (o PUR kyu la)—
one is an operculum. A crawling snail
keeps this hard door on its back.

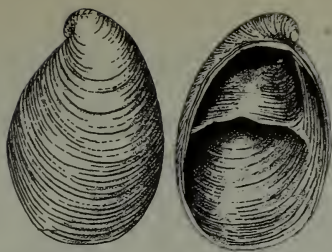
But when a snail is alarmed, it draws into its shell
and closes the opening with its operculum.

It may cover the whole opening,
like the operculum of one petrified snail
that is shown on page 31.

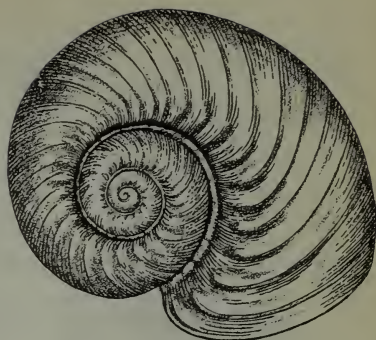
Other opercula are not so large,
and they fit so far back in the shells
that they cannot be seen.



Murex
(Oligocene)



Crepidula (Eocene)
Two views of one shell



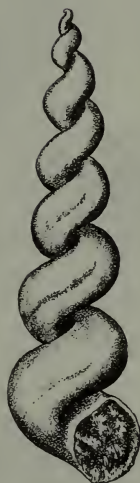
Gyrodes (Cretaceous)



Acteon (Miocene)



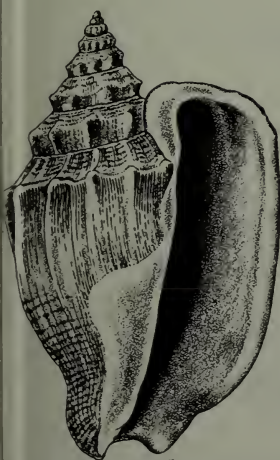
Turritella
(Paleocene-Eocene)



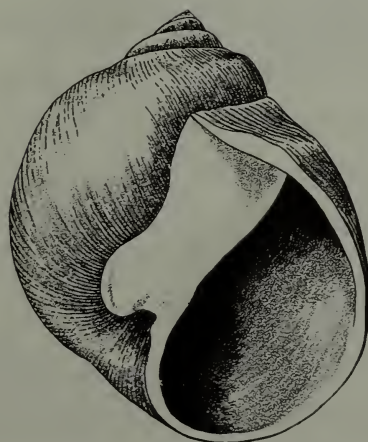
Turritella
Internal mold



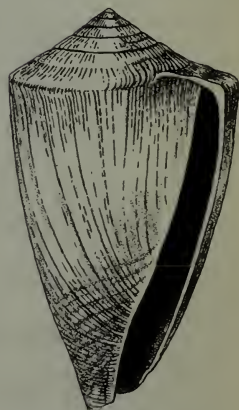
Volutocorbis
(Eocene)



Strombus (Miocene)



Lunatia (Miocene-Recent)



Conus (Oligocene)

Some Cretaceous and Tertiary snails.



One Nautilus is swimming, but the other is crawling with its arms.

THE NAUTILUS

The only living kind of Nautilus (NAW ti lus) is found in the Pacific Ocean, near Asia.

The creature resembles a tightly coiled snail, but its foot has become soft, pointed arms and its eyes have grown big and round.

The shell also is not one simple coil like the shell of an ordinary snail.

If you cut a Nautilus shell in two you will find that it is divided into sections, or chambers, by curved partitions which we call septa (SEP tah).

A tube that runs through chamber after chamber is known as the siphuncle (SY funk el).

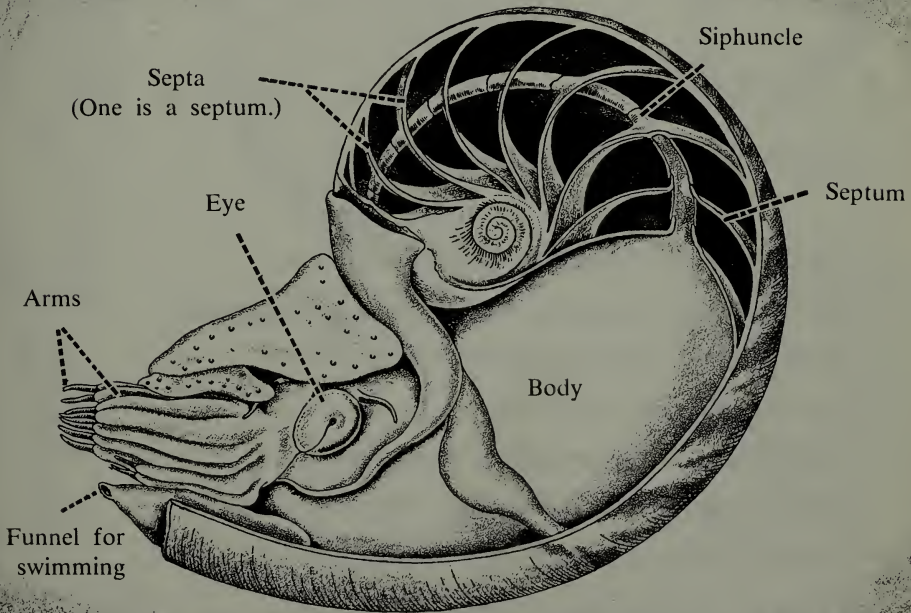
The tube is partly filled with flesh, but the creature's short, soft, pinkish body stays in the outermost part of the shell.

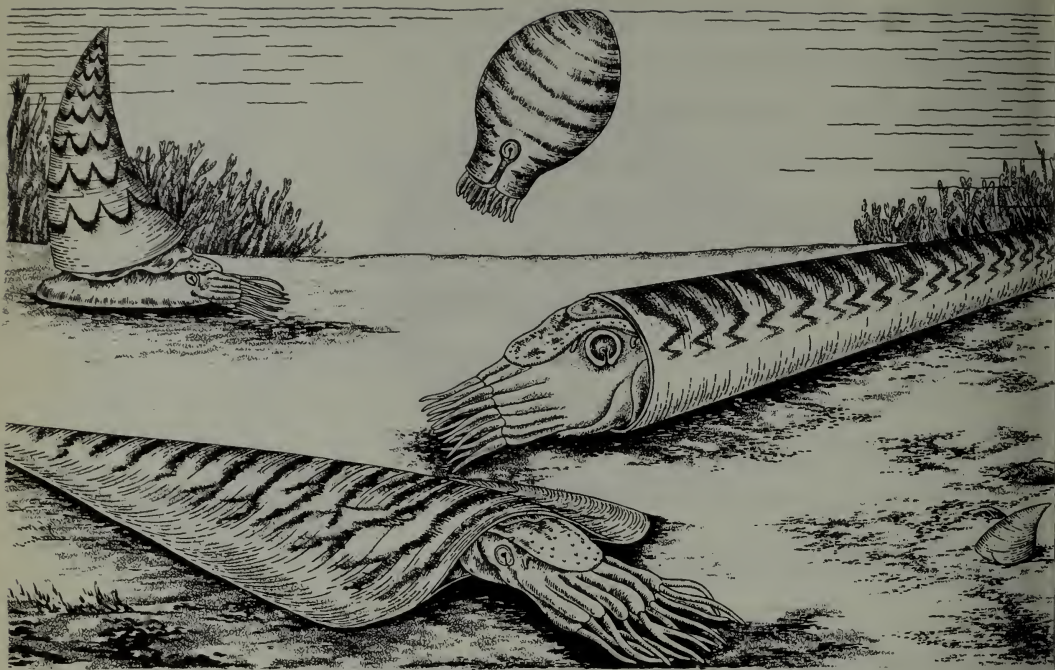
There the Nautilus can stretch out its arms to catch food or crawl on the sea bottom.

When a Nautilus is frightened, it sucks in water and squirts it out again in jets through a soft "funnel" under the head.

Those jets make the creature swim backward much faster than it can crawl.

A Nautilus cut to show the parts of its shell and body.





Four ancient horn-shells as they looked when they were alive.

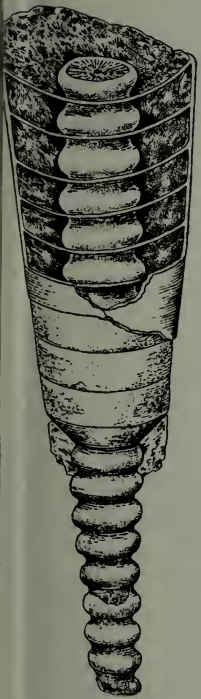
ANCIENT HORN-SHELLS

Nautilus now lives in the Pacific Ocean, but fossils with siphuncles, septa, and chambers are found in North America, Europe, and other parts of the world.

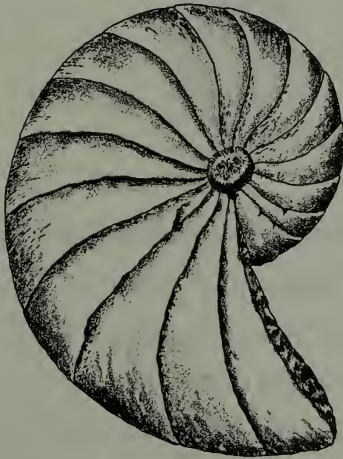
We often call these fossils “nautiloids” because they are built like Nautilus shells.

We may also call the fossils “horn-shells” for many of their names end in c-e-r-a-s, which is the ancient Greek word for horn.

Most horn-shells lived during Paleozoic ages, between 490 million and 220 million years ago. Many kinds built long, straight shells. Other kinds were flattened, curved, or coiled, and some looked like vases or ice-cream cones. Many of the shells were smooth, but others had ridges that ran lengthwise or wrinkles that went round and round. These wrinkles show plainly on one fossil at the bottom of this page.



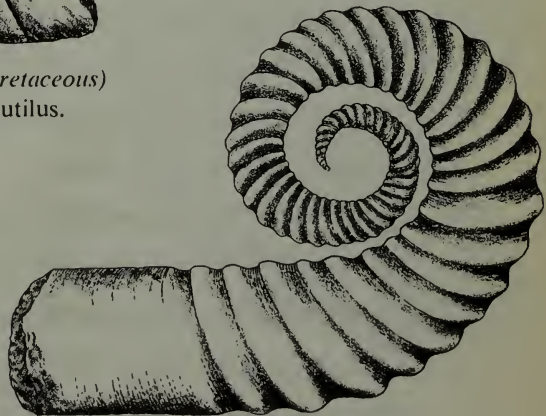
This *Actinoceras* (*Ordovician*) shows both septa and siphuncle.



Eutrephoceras (*Cretaceous*) resembled *Nautilus*.

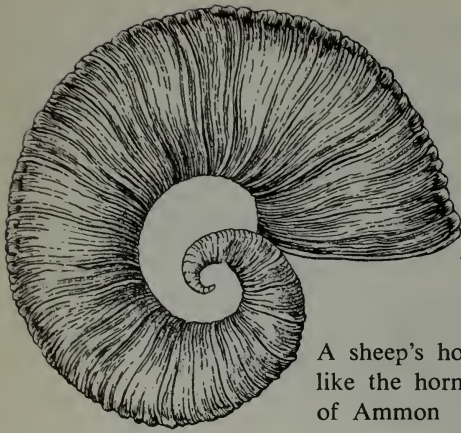


Hexameroceras (*Silurian*)

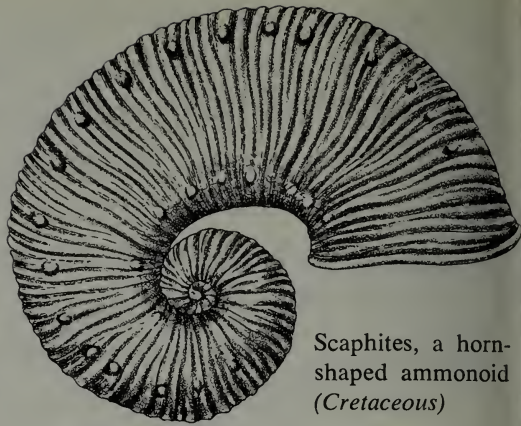


Bickmorites (*Ordovician*) was partly uncoiled.

Four fossil horn-shells of various ages.



A sheep's horn,
like the horns
of Ammon



Scaphites, a horn-
shaped ammonoid
(Cretaceous)

“AMMON’S STONES”

Ammonoids (AM uh noidz) are fossil shells whose name means “things like Ammon.”

Ammon was a god of ancient Egypt who sometimes looked like a man, and sometimes became a sheep with coiled horns. Some ammonoids look like wrinkled horns, but other kinds are coiled much more tightly than the shell of Nautilus.

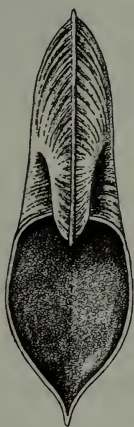
Some tightly coiled shells are plump and smooth or are covered with ridges and knobs.

Other tightly coiled ammonoids are narrow and each one has a thin edge, called a keel, that runs around the shell.

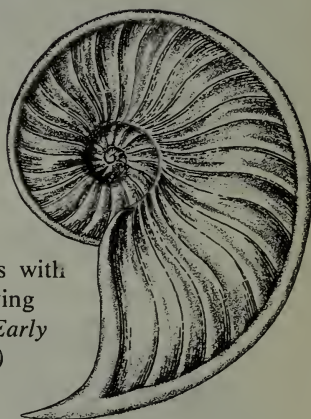
Still others, such as *Baculites* (BAK yu LY teez),
grew in coils when they were young.
Then, as these ammonoids grew older,
they began to build straight, narrow shells
that became much larger than the coils.



Arcestes (Triassic)



Dipoloceras with
shell, showing
the keel (Early
Cretaceous)



Manticoceras (Late Devonian)



Mortonicerias (Late Cretaceous)

Several types of ammonoids.

Plump ammonoids probably crawled on the sea bottom,
but the kinds that had narrow shells
were able to swim like Nautilus.

No one knows how Baculites lived.

Perhaps it swam with its arms hanging downward.

Perhaps it half-swam and half-crawled
with its straight part and body near the bottom
where the arms could capture food.

• • •

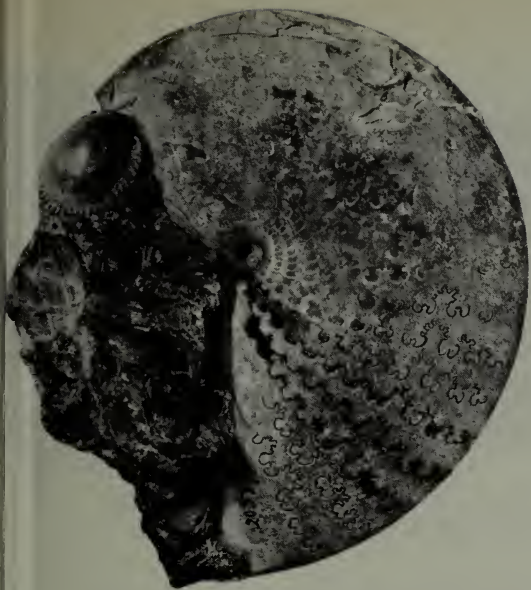
The easiest way to tell ammonoids from nautiloids
is to look at their septa.

The septa of nautiloids are curved like saucers,
and their edges make straight or curved marks
called sutures (SOO churz)

where they come to the outer part of the shell.

But the septa of ammonoids are crumpled,
and they produce sutures that bend to and fro
or are wriggly lines that remind us of lace.

Sutures do not show on the outsides of shells,
but they are easily seen on internal molds
or on fossils whose shells have been worn down
to a few thin layers.



Sphenodiscus (*Early Cretaceous*)



Baculites, showing sutures
(*Late Cretaceous*)



Baculites
(*Late Cretaceous*)



Dipoloceras (*Early Cretaceous*)

Some ammonoids and their sutures.



Belemnoids built shells inside their bodies. The large specimens are Belemnitella. (*Cretaceous*)

BELEMNOIDS

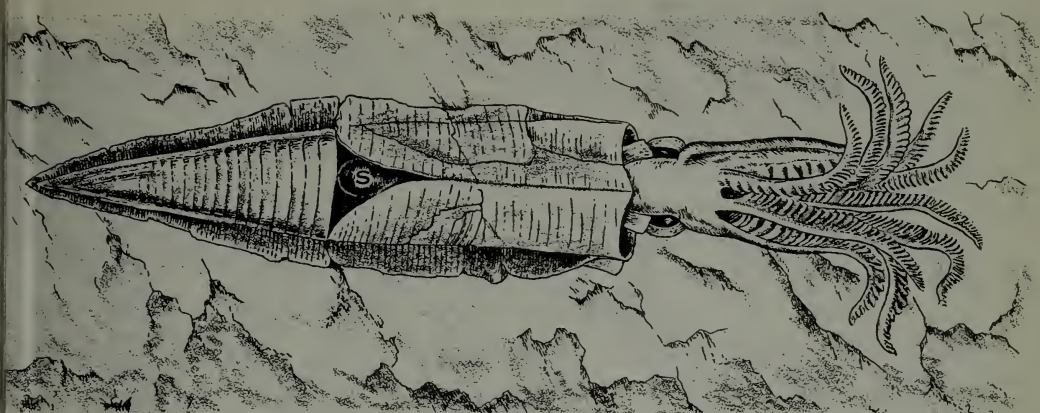
These fossils were once called thunderbolts which lightning had driven into the ground. They really are petrified shells which creatures called belemnoids (BEL em noidz) developed inside their bodies.

Belemnoids were related to Nautilus, but they looked and probably acted like squids, which are common in the sea today.

Belemnoids had big round eyes, slender bodies, and two fins that spread sideways, not up and down.

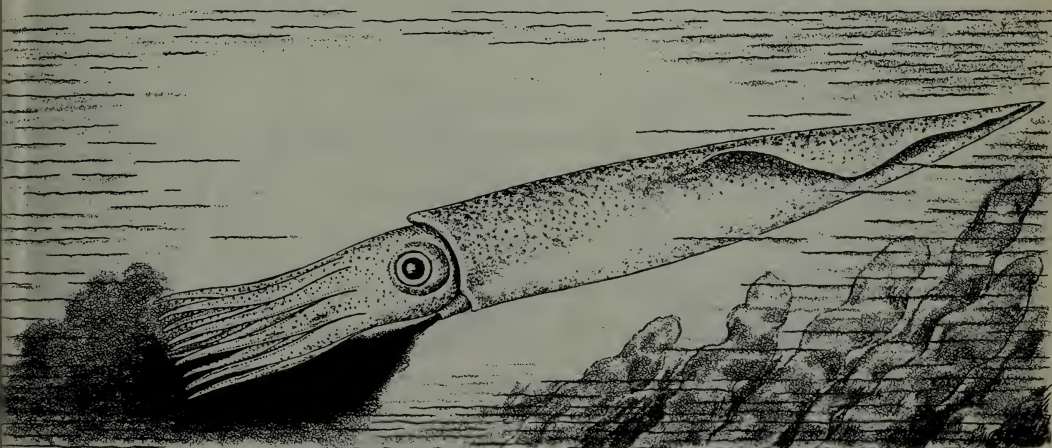
Ten pointed arms were provided with hooks which were used to catch little fish.

The front part of each shell, called the cone, was built like a little, straight horn-shell.



This fossil belemnoid shows flesh, eyes, arms, and ink sac (S).

The hind part of the shell, called the guard, stiffened the body and kept it from wobbling. Most fossil belemnoids are petrified guards, but a few show arms, eyes, and pouches, or sacs, that once were filled with inky liquid. When danger threatened a belemnoid, it squirted ink into the water and so kept enemies from following as it swam away.



This belemnoid squirted ink as it swam away from danger.



Fossil lamp-shells, or brachiopods, in a slab of limestone.

LAMP-SHELLS ARE NOT CLAMS

These fossils are shells of animals whose proper name is brachiopods (BRAK i o podz). We often call them lamp-shells, however, because some kinds are shaped like lamps that once were used in Greece and Rome. If you could examine a living brachiopod you would find that its soft little body is quite different from the body of a clam.



One part, or valve, of a lamp-shell



An ancient lamp

Some brachiopods are shaped like ancient lamps. Because of this, the whole group is often called lamp-shells.

Most fossils show no trace of the body, but you can tell a lamp-shell from a clam if you draw lines that divide each one into similar but opposite halves.

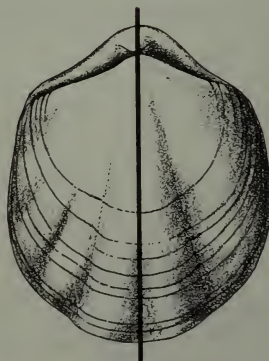
In the clam, your dividing line will go between the shell's two sections, or valves.

In the brachiopod, or lamp-shell, however, your line will go straight across both valves.

There is no other way to divide a lamp-shell into similar though opposite halves.



Clam



Lamp-shell



How to tell a lamp-shell from a clam by dividing each one into opposite halves.

MANY DIFFERENT LAMP-SHELLS

Ten thousand kinds of clams have been found on seashores and in modern seas.

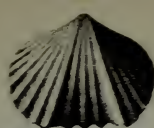
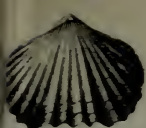
Modern lamp-shells are not so plentiful.

They number only about 110 kinds, but their relatives were more common than clams during most of the Paleozoic Era.

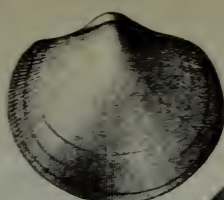
No one knows how many kinds there were, for scientists constantly find new ones in almost all parts of the world.

Pictures on page 47 show a few of the commonest and best-known kinds, or species (SPEE sheez), that have been found in North America.

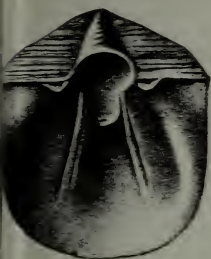
All these fossils lived during the Paleozoic Era, for lamp-shells never were plentiful after it came to an end.



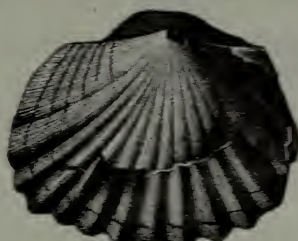
Orthorhynchula
(*Ordovician*)



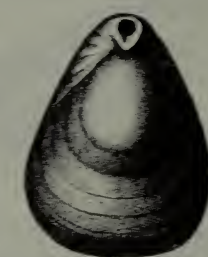
Schizophoria (*Devonian*)



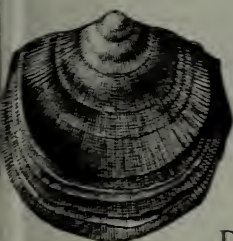
Billingsella
(*Cambrian*)



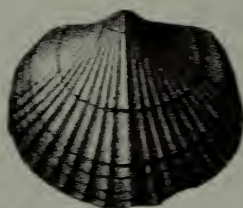
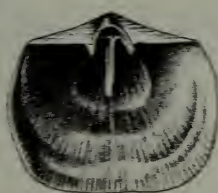
Meekella
(*Pennsylvanian-Permian*)



Dielasma
(*Pennsylvanian-Permian*)



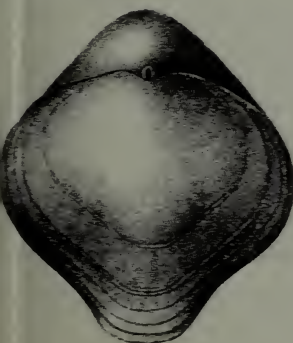
Derbyia
(*Pennsylvanian*)



Tropidoleptus (*Devonian*)



Brachyspirifer
(*Devonian*)



Meristella (*Devonian*)

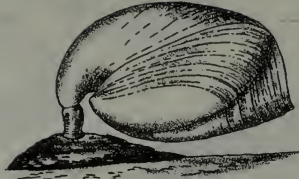
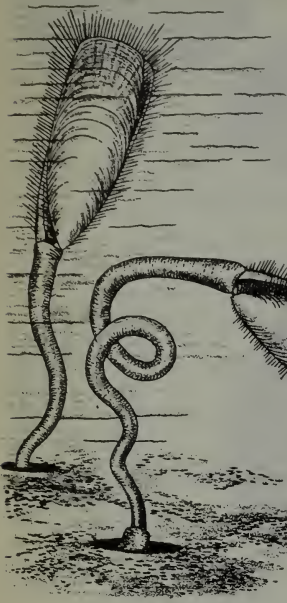


Rensselaeria (*Devonian*)



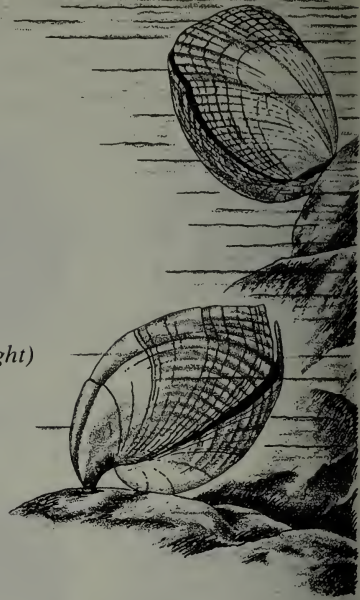
Conchidium (*Silurian*)

Some common lamp-shells, or brachiopods.



Composita, a fossil lamp-shell,
was fastened to other shells.

Terebratulina (*right*)
fastens itself to
rocks.



Lingula is a modern lamp-
shell that digs into sand
with a fleshy stalk.

HOW DID LAMP-SHELLS LIVE?

When we collect petrified lamp-shells
we soon want to know how they lived.

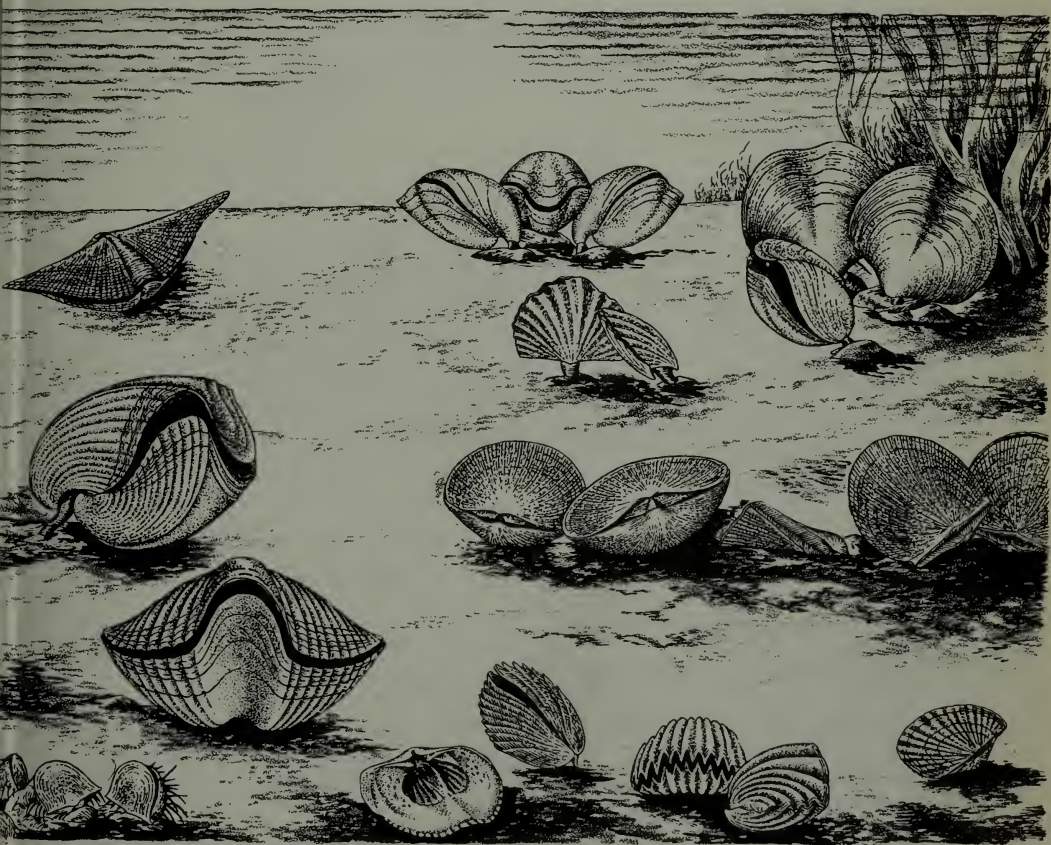
The best way to find out is to look at our fossils
and then compare them with lamp-shells
that are found in the sea today.

Some fossils, for example, look like Lingula.

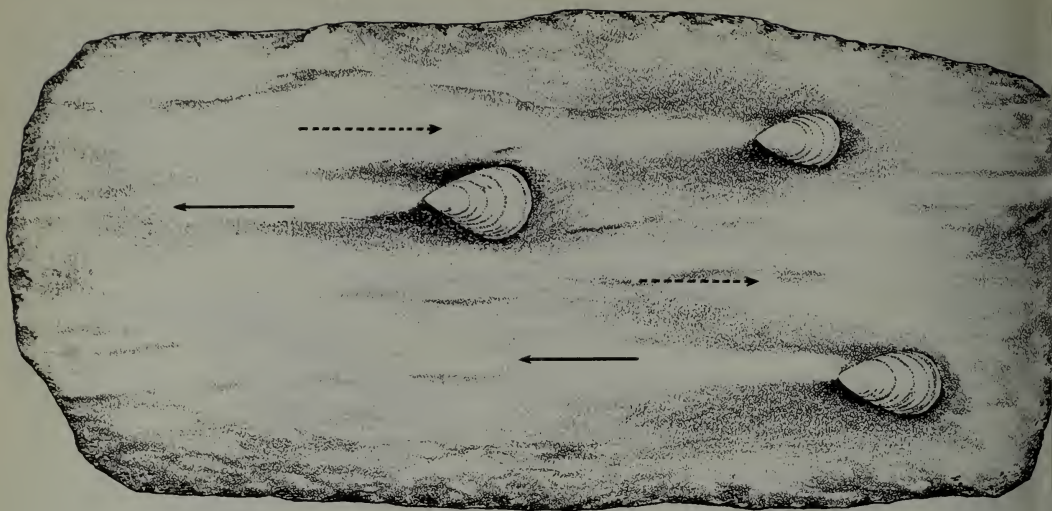
Lingula (LING gu la) lives under shallow water,
and digs into the sand with a long, tough stalk
that can twist to and fro like a worm.

Other living lamp-shells have short, strong stalks
that are fastened to rocks.

Fossils like *Lingula* must have had stalks which dug down into soft mud or sand. Other fossils resemble rock-dwelling species but lived where there were no stones. Such creatures fastened themselves to shells, but other kinds, which had lost their stalks, lay on quiet, muddy sea bottoms. This picture shows several stalkless lamp-shells, as well as other kinds that had stalks.



Lamp-shells as they lived on the bottom of a Devonian sea.



Broken arrows show the direction in which a wave traveled as it washed these *Lingula* shells ashore. Unbroken arrows show how the water ran back, leaving ridges behind the shells.

SLABS FROM ANCIENT SHORES

When we walk on the seashore, we often find that waves and currents have piled the sand into ridges known as ripple marks.

This also happened in prehistoric times for there were currents and waves in ancient seas, just as there are today.

In time, ripple-marked sand often hardened into beds of sandstone like the big slab that is shown at the bottom of page 51.

Ripple-marked rocks are interesting, but they almost never contain good fossils.

You can easily tell the reason for this,
since currents, waves, and shifting sand
soon ground dead, empty shells to pieces.
Sometimes, however, mud covered the shells,
protecting them while they became fossils
and while the loose, wet sand became stone.
The piece of rock on page 50 shows three shells
which became fossils after they were washed ashore
during the Silurian Age.



Small waves made ripple marks on this sandstone near the shore
of a late Ordovician sea which covered part of Ontario.



Two living starfish on a rock near the Pacific Ocean.

ANIMALS WITH SPINY SKINS

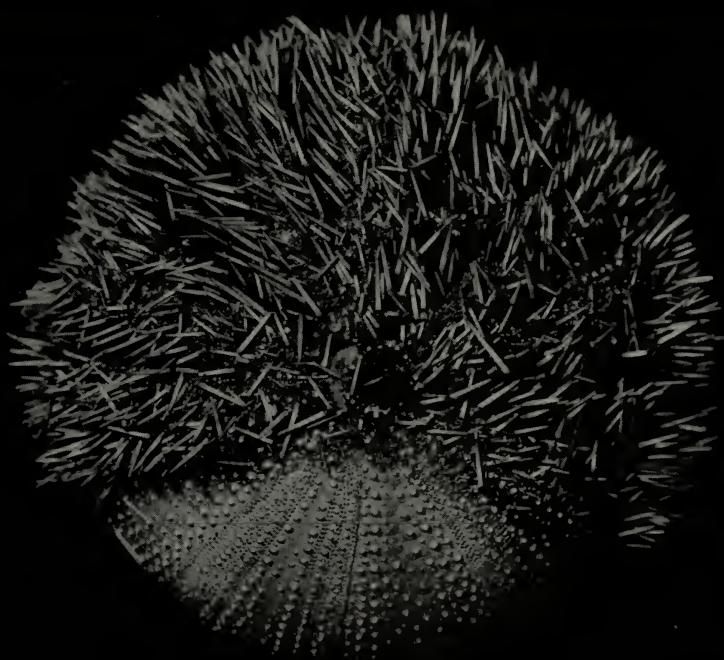
Starfish got their name long, long ago,
when “fish” meant almost any creature
that lived in rivers, lakes, or the sea.

Starfish plainly are not like cod or goldfish,
which have heads, eyes, tails, and scaly skins
and swim with fins on their bodies and tails.

A starfish has none of these things.

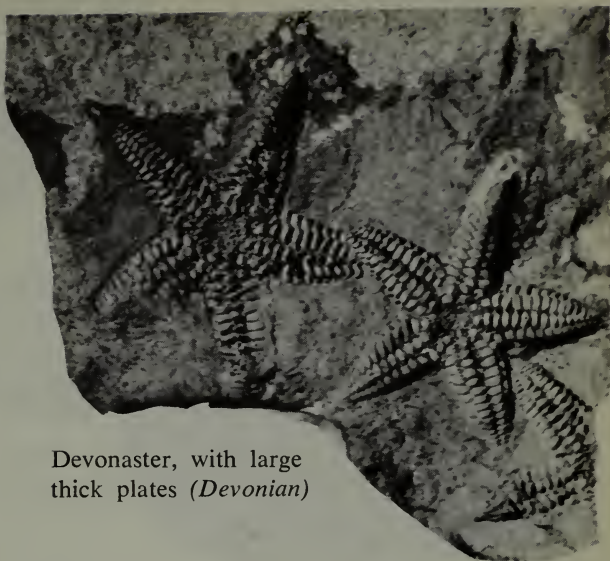
Instead of swimming it crawls on tiny, soft legs.
Instead of having bones and scales,
its skin is filled with spines and hard pieces.
These show that each starfish belongs to the group
of animals called echinoderms (ee KY no durmz),
a name made from two Greek words
that mean "spiny" and "skin."
You can see spines in the skin of starfish,
but they show still more plainly on sea urchins,
which also have shells made of hard, stony plates.

This sea urchin's spines are fastened to a shell made of stony plates.



STARFISH

The first starfish were little animals
whose five broad arms were parts of their bodies
and whose skins were filled with slender plates.
Then came creatures with slightly narrower arms
and plates which were thick and rounded
but never were sharp, prickly spines.
As ages went by, new kinds of starfish developed.
Some still were covered with rounded plates,
but others had soft, skin-covered bodies
that spread out to the tips of their arms.
Brittle stars developed small, round bodies
and arms that could twist like little snakes.
Fossils of all these creatures are rare,
for they fell to pieces soon after they died.
You will be lucky if you find a fossil starfish,
and luckier still if you discover a slab
that is covered with these rare fossils,
like the piece of Cretaceous limestone
at the bottom of page 55.



Devonaster, with large
thick plates (*Devonian*)

A serpent star from
Germany (*Devonian*)

Austinaster in a slab of
limestone from Texas
(*Cretaceous*)

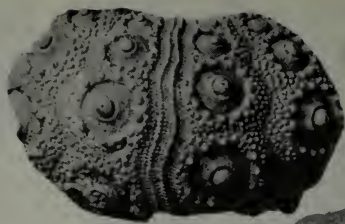
H. A. Gotthold



Three kinds of fossil starfish.



Clypeaster (*Miocene*). Found near the famous pyramids of Egypt.



Cidarid (*Jurassic*).
Other kinds range from Triassic to Recent.

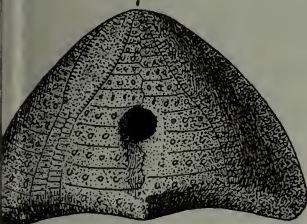
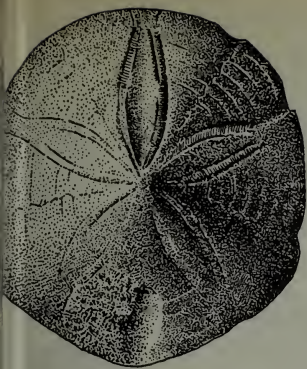
Two kinds of fossil sea urchins. Both have lost their spines.

SEA URCHINS AND SAND DOLLARS

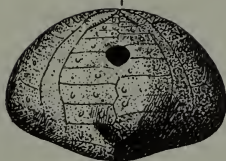
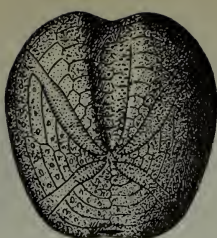
An urchin is now a boy with old, worn clothes, but sea urchins got their name at a time when this word meant almost any small creature that had a rough or prickly skin.

We know that sea urchins are echinoderms. They have shells made of hard, stony plates which are covered with spines.

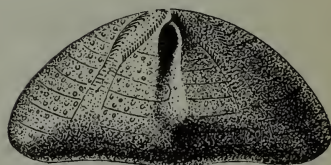
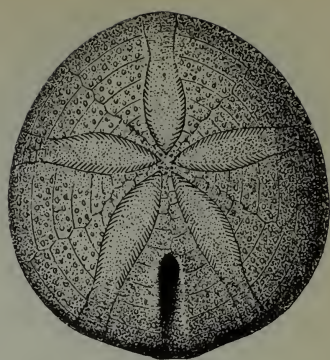
Some spines are almost as thin as hairs, but others are thick, and long, and sharp.



Cassidulus
(Cretaceous)



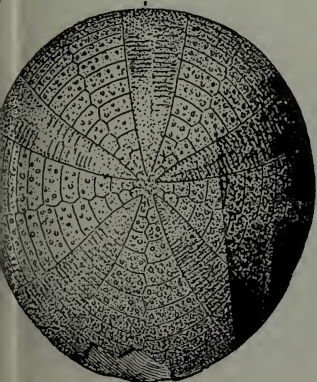
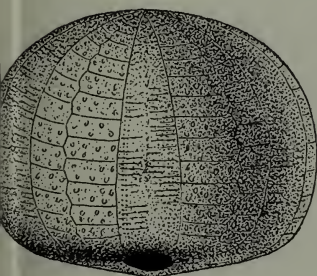
Enallaster
(Cretaceous)



Cassidulus
(Cretaceous)



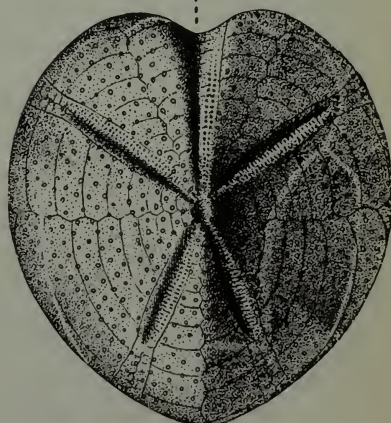
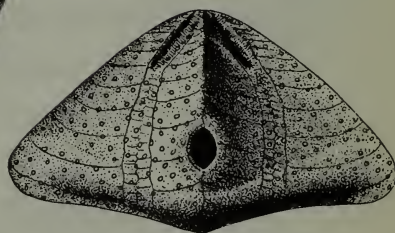
Holactypus
(Cretaceous)



Holaster (Cretaceous)



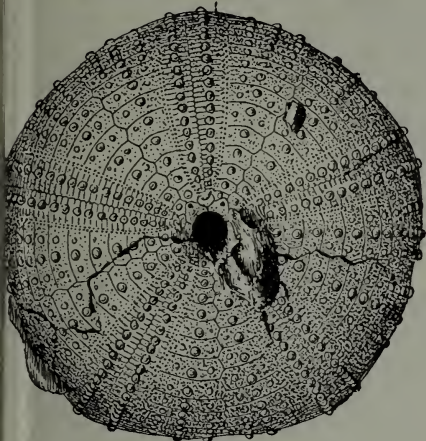
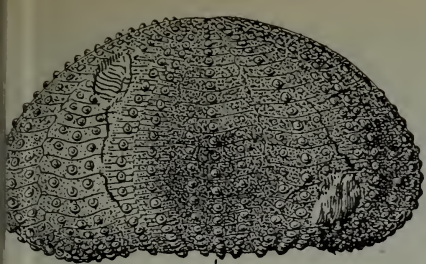
Echinobrissus
(Cretaceous)



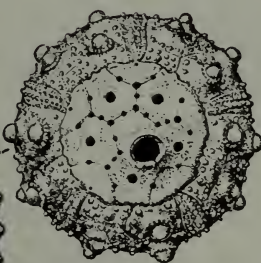
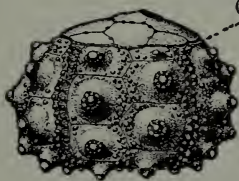
Linthia (Eocene)

Some common sea urchins.

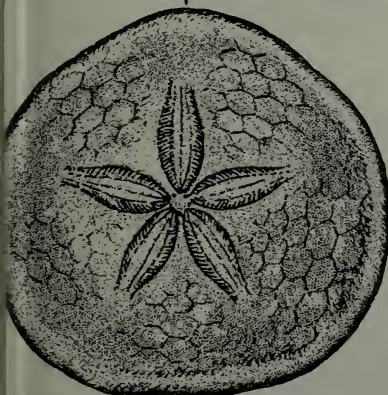
The large urchin on page 56 had short spines,
but the spines of Cidaris (SID uh ris) were long.
The oldest known sea urchins lived
during the Ordovician Age,
but these creatures did not become common
until Mesozoic and Cenozoic times.
The first sea urchins were round
and looked like small melons, not spiny animals.
But as ages went by, these creatures changed.
Some kinds became oval or heart-shaped,
with flattened undersides,
but others looked like one half of a ball.
Many shells were thin and smooth,
but others grew thick or were covered with knobs
to which the spines were fastened.
Strangest of all were the sand dollars.
They became wide and flat, like cookies,
yet their plates were so thick that they left
only a little space for the body.
Some kinds also developed notches and "keyholes"
that went all the way through their shells.



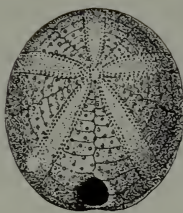
Orthopsis (*Cretaceous*)



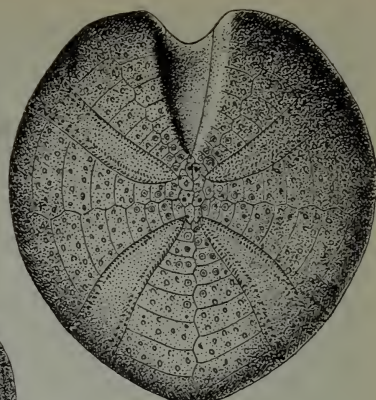
Salenia
(*Cretaceous*)



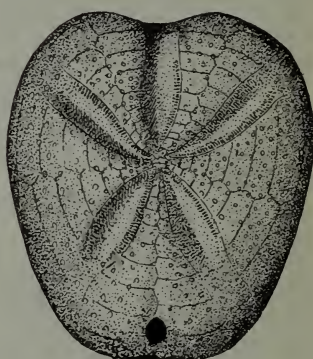
Protoscutella, a sand
dollar (*Eocene*)



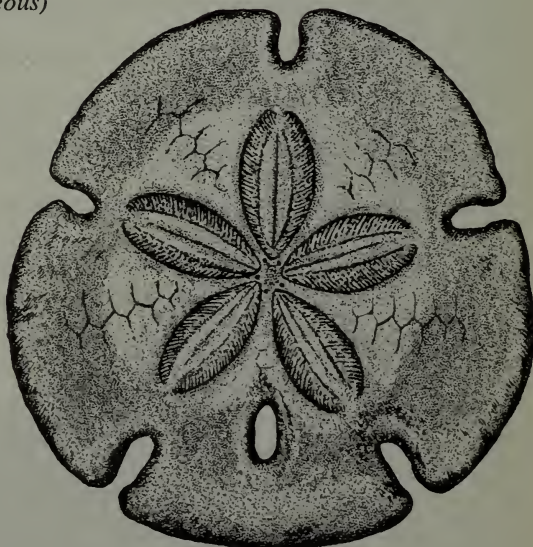
Trematopygus
(*Eocene*)



Cardiaster
(*Eocene*)



Epiaster
(*Cretaceous*)

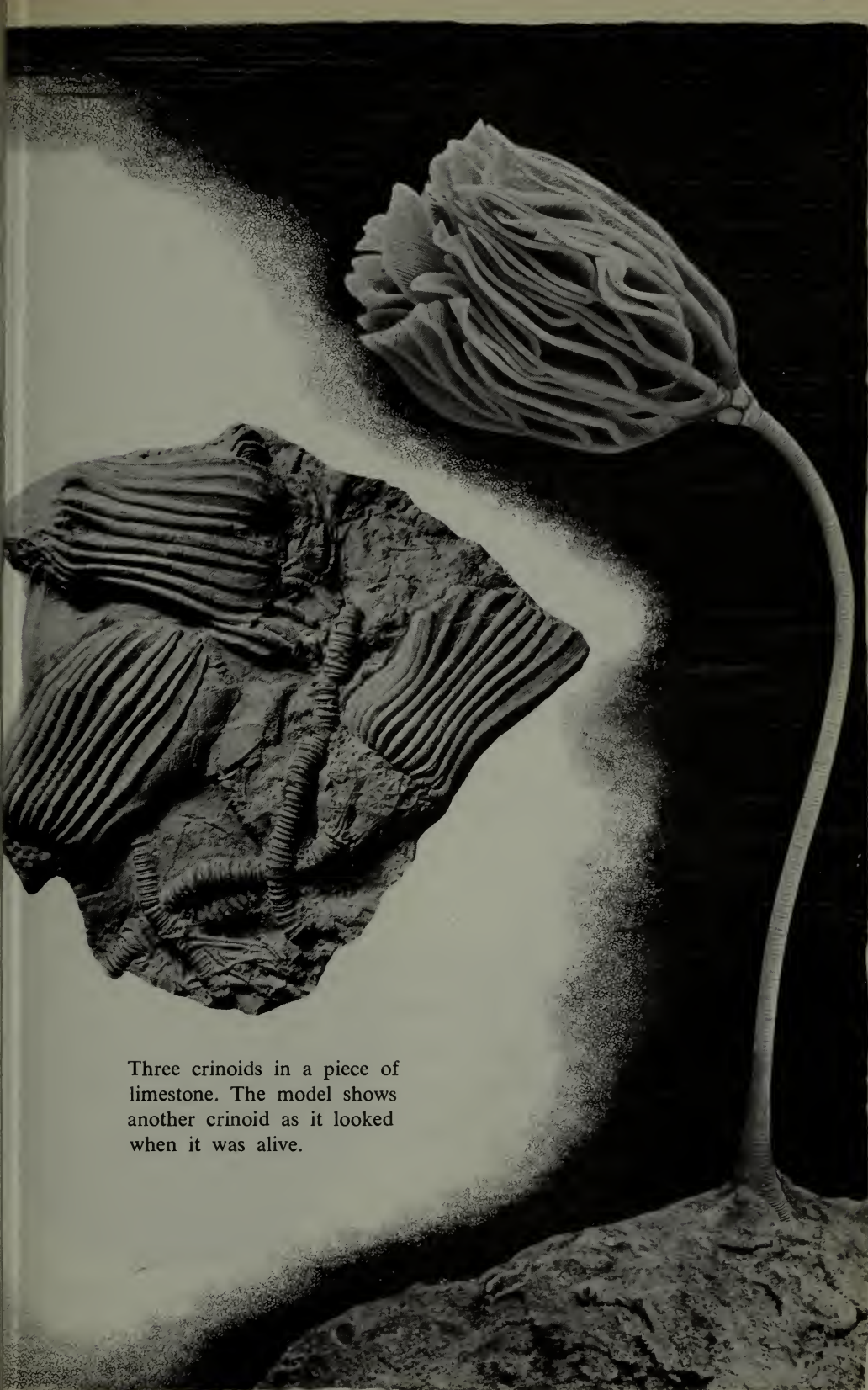


Encope, a keyhole urchin
(*Pliocene-Recent*)

Sea urchins and sand dollars.

SEA LILIES, OR CRINOIDS

Starfish do not resemble real fish
and sea urchins are very different from boys
and from small, spiny creatures that live on land.
But sea lilies, or crinoids (KRY noidz),
look like flowers, even though they are animals
that belong to the group of echinoderms.
Modern crinoids crawl or live on sea bottoms.
Some fossil sea lilies drifted in "schools,"
but most of these creatures stayed on the bottom.
There they built stiff, jointed stalks
that ended in roots or spreading holdfasts
which clung tightly to the mud or to shells.
On top of each stalk was a plate-covered body
which was large and cup-shaped in some species
but was very small in others.
Jointed arms that grew upward from the body
had many small branches, or pinnules (PIN yoolz).
When a crinoid felt hungry
its jointed pinnules bent to and fro,
sending currents of water to the mouth,
which was on top of the body.

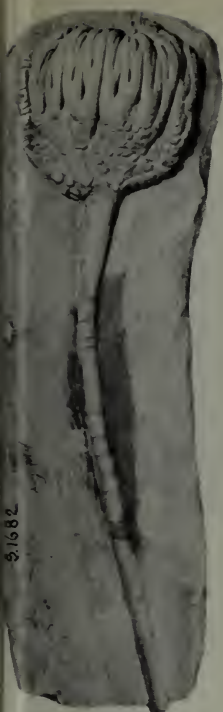


Three crinoids in a piece of limestone. The model shows another crinoid as it looked when it was alive.



These sea lilies, called Uintacrinus, had no stalk. They drifted freely in a sea that covered a large part of the West during the Cretaceous Age.

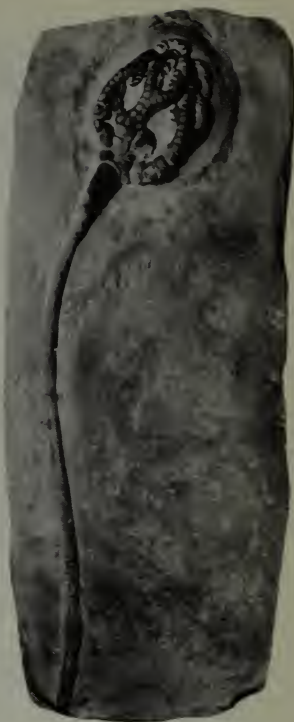
There tiny plants and animals were caught in sticky material called mucus (MYU kus). When the mucus had all the food it could hold the sea lily swallowed it, made some more mucus, and began to catch food again.



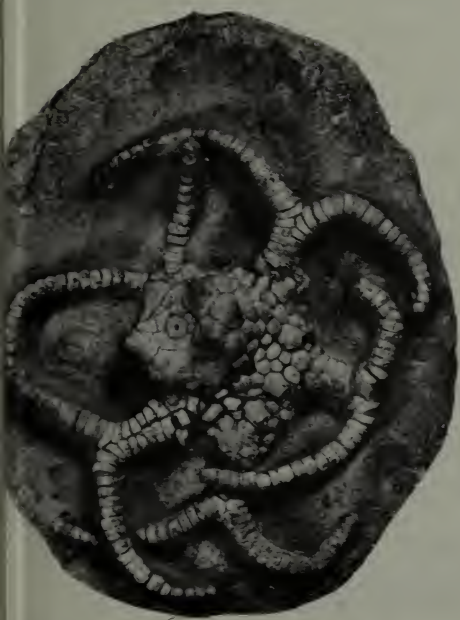
Forbesiocrinus
(Mississippian)



Platycrinites
(Mississippian)



Onychocrinus
(Mississippian)

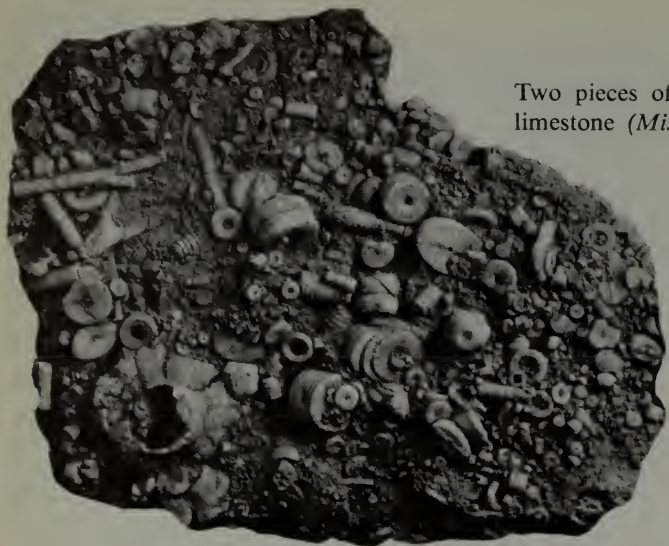


Gilbertsocrinus (Mississippian)

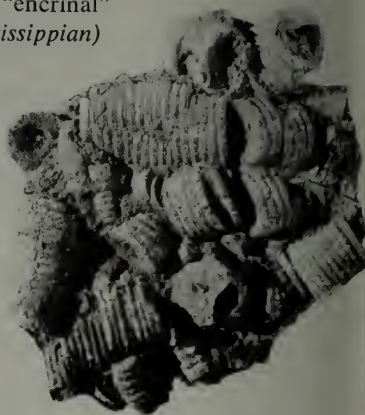


Megistocrinus (Mississippian)

Some crinoids of the Mississippian Age.



Two pieces of "encrinal"
limestone (*Mississippian*)



SEA BUDS AND "ENCRINAL" LIMESTONE

Most crinoids built jointed stalks, and so did two other groups of ancient echinoderms. Some of those called cystoids (SIS toidz) had arms, but the sea buds, or blastoids (BLASS toidz), had only armlets that waved to and fro, sending water and food to the mouth. Sea buds covered themselves with thick plates which were fastened together so tightly that their bodies often became fossils. Most crinoids were not so strongly built, and their bodies often broke into pieces soon after the animals died.

The jointed stalks of crinoids broke easily, too,
and so did the stalks of sea buds.

When crinoids or sea buds grew in crowded banks,
broken stalks soon covered the sea bottom
and formed beds of rock which we often call
crinoidal, or encrinal (en KRY nal), limestone.

The pieces of encrinal limestone shown on page 64
are made up of broken crinoid stalks
held together by hardened mud.



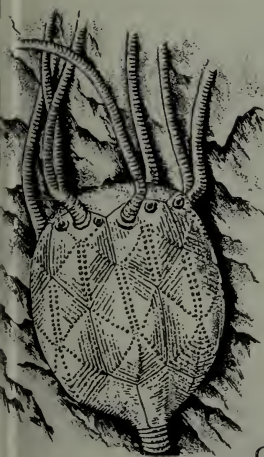
Orophocrinus
(Mississippian)



Nucleocrinus
(Devonian)



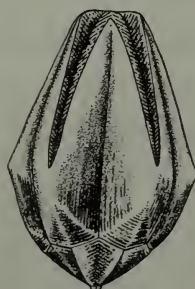
Pentremites (*Mississippian*). A fossil with part
of its stalk and the whole
animal as it looked when
it was alive.



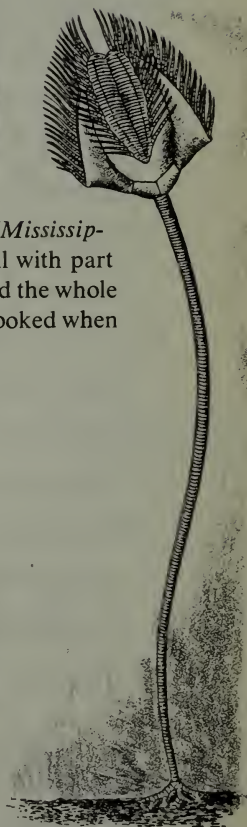
Caryocrinites, a cystoid
with arms. (*Silurian*)



Troostocrinus
(*Silurian*)



Tricoelocrinus
(*Mississippian*)



A cystoid and several sea buds, or blastoids.

THREE LOBES; THE TRILOBITES

Persons who find fossils like these
sometimes call them "petrified butterflies."

We say they are trilobites (TRY lo bites),
which means "three-lobed animals."

You can easily see that this name is a good one
for grooves divide each trilobite's body
into three lengthwise portions, or lobes.

When these trilobites were alive they swam
or crawled on sea bottoms with their jointed legs.
They watched for danger with big, glowing eyes
but used their feelers (which also could smell)
to find things that were good to eat.

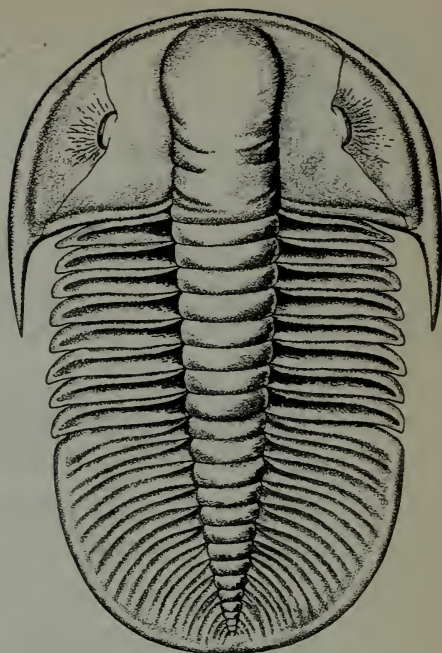
Each trilobite ate until he became too large
for the crust that covered his skin like a shell.

Then the skin-crust split and the creature crept out.
He hid under seaweeds while he grew still larger
and while his skin built a new crust.

It would stiffen his body and protect him
when he went crawling and swimming again.

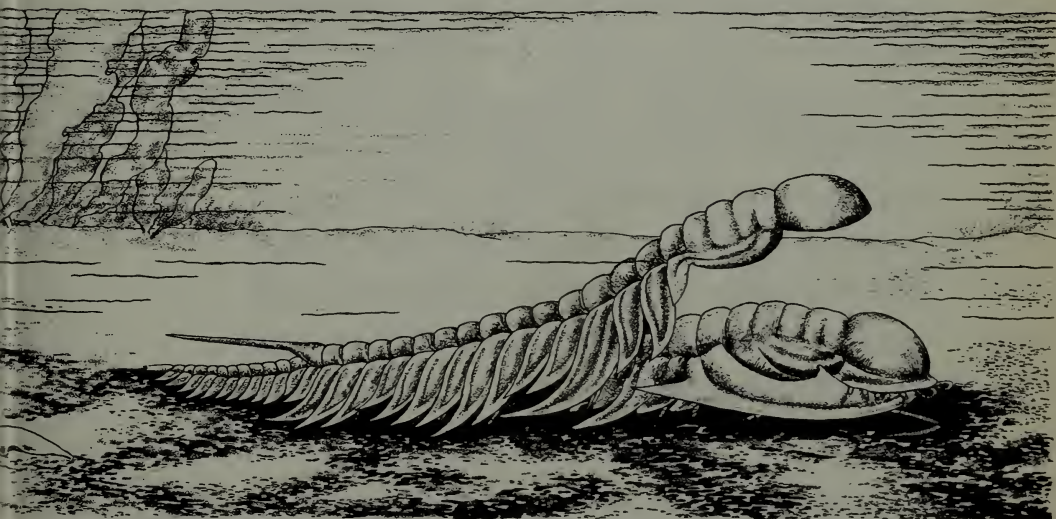


Olenellus (*Early Cambrian*)



Ogygopsis (*Middle Cambrian*).
Many sections at the end of
the body have been joined
together in the "tail."

Olenellus crawling out of its old skin-crust, which has become too small.



Trilobite bodies had three lengthwise lobes.

LITTLE AND BIG TRILOBITES

The trilobites on page 67 are good-sized,
for both were more than three inches long.

Many trilobites were smaller than these,
but a few kinds became much larger.

Agnostus (ag NOSS tus) was one of the smallest,
for his jointed body contained only four sections
only twice as large as this letter "O."

Proetus (pro EE tus) and Aeglina (ee GLEE na)
were both wider and longer than Agnostus,
and their bodies contained more sections.

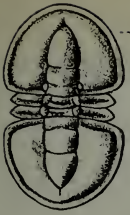
So did the body of Terataspis (TEHR uh TASS pis),
a trilobite that often grew to be twenty-seven inches long.

Terataspis had knobs, points, and curved spines
on almost every part of his skin-crust.

These four trilobites are shown on page 69.

Terataspis is less than one fourth as big as life,
but Agnostus and Proetus are so tiny
that they are drawn on a much larger scale.

Black dots show what they would look like
if they, too, were drawn one fourth as large
as their fossils really are.

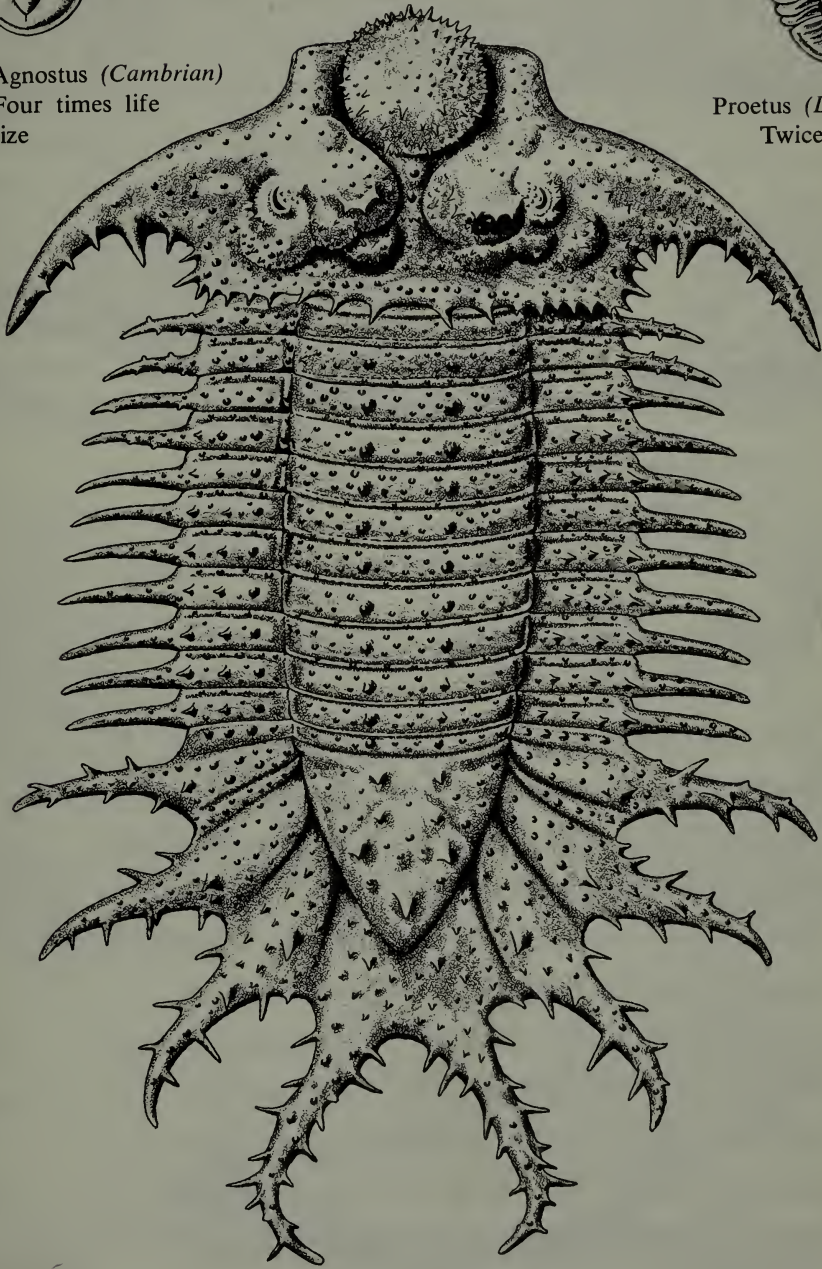


Aeglina (*Ordovician*)
Twice life size



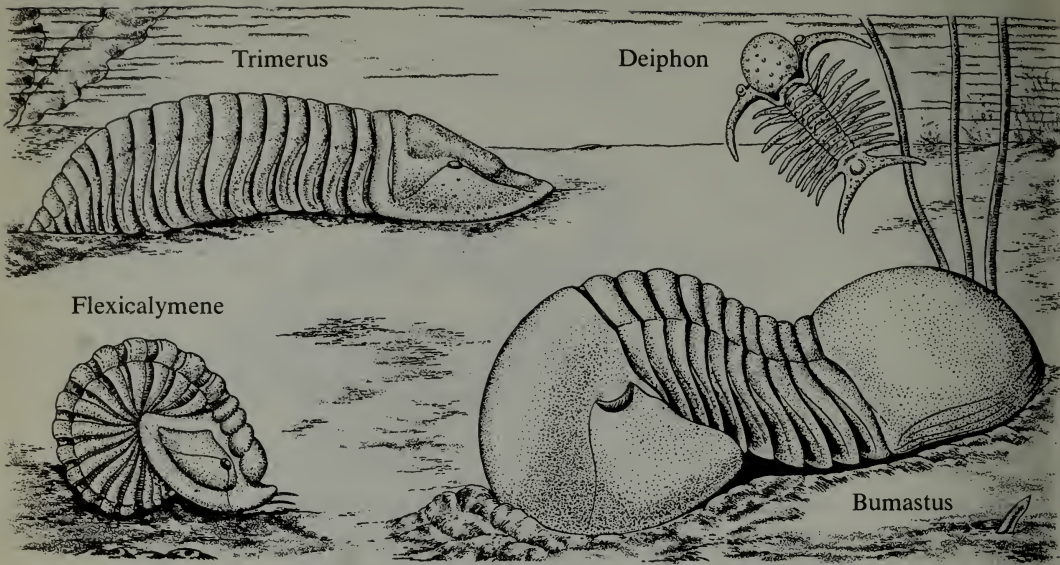
Proetus (*Devonian*)
Twice life size

Agnostus (*Cambrian*)
Four times life
size



Terataspis (*Devonian*), a giant trilobite twenty-five to twenty-seven inches long.

Small and large trilobites.



These trilobites lived in different ways.

HOW TRILOBITES LIVED

When we examine fossil trilobites closely we frequently find out how they lived.

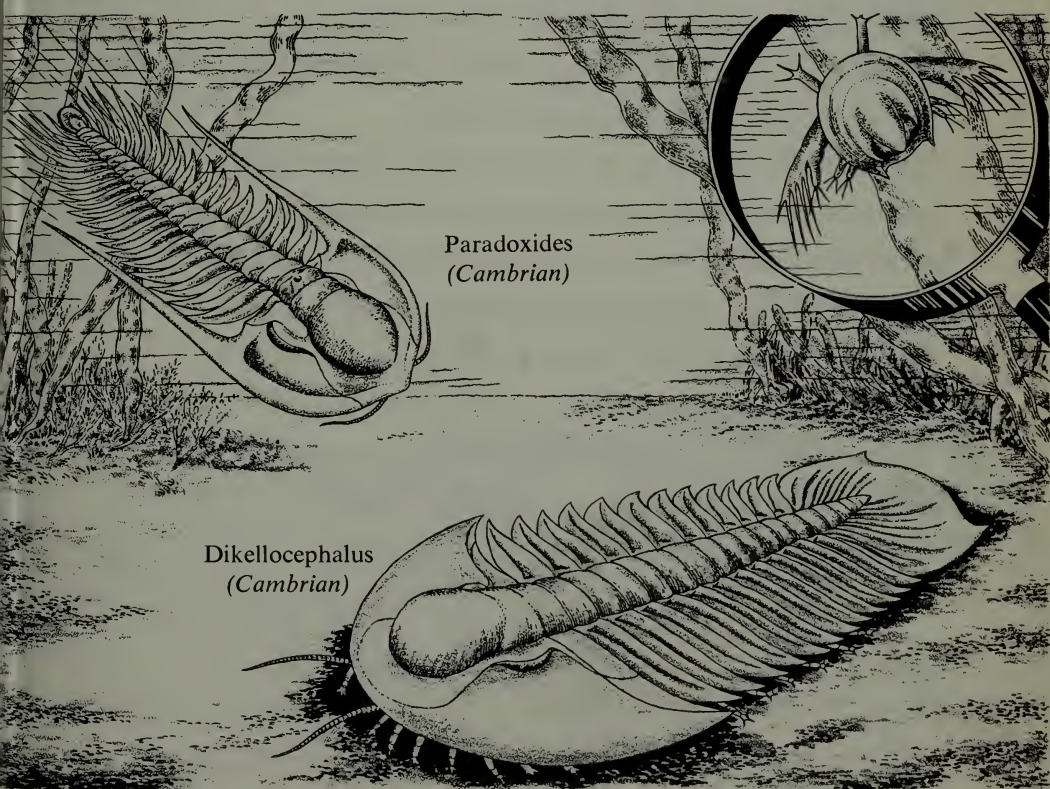
Many-jointed kinds often crawled on sea bottoms, where they dug up worms for food.

Broad, flat trilobites swam easily and swiftly or “skimmed” along with the tips of their feet touching the sandy or muddy sea bottom.

Small, spiny trilobites and very young ones drifted to and fro or clung to seaweeds.

Smooth species often dug their tails into mud and lay quietly, eating dead things and plants that drifted over the sea bottom.

Other trilobites with rounded heads and tails pushed themselves through mud, plowing it up to get small animals which they ate. Several kinds that had thick, strong skin-crusts crawled about while they were feeding but rolled up as soon as they were disturbed. The hard, jointed crusts were like armor, which covered the animals and kept them from harm. Rolled-up crusts sometimes became fossils which are found in beds of clay or soft shale.



A swimmer, a skimmer, and a trilobite baby clinging to seaweed.

CRABS AND MUD SHRIMPS

When we hunt for shells along the seashore we often find remains of crabs.

Crab shells, of course, are really skin-crusts which are made thick and hard by limy material.

As crabs grow, they shed their old crusts and make new ones, just as trilobites did.

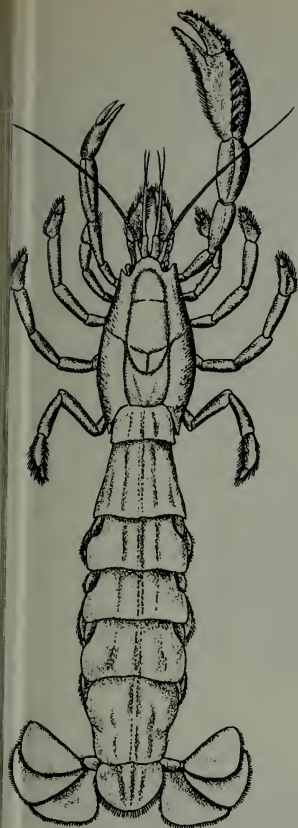
Old, empty skin-crusts seem very strong, but they seldom last long enough to be petrified.

You may never find a petrified crab, but legs and pincers, or "claws," of mud shrimps are common in soft, sandy rocks of Tertiary age near the Gulf of Mexico and the Pacific Ocean.

Animals related to these prehistoric mud shrimps still burrow in mud or sand under shallow bays.

We often call these burrowers "ghost shrimps" because they are pale whitish yellow.

This makes them look as if they were dead while they are still alive.



A crab, *Avitelmessus* (*Late Cretaceous*)



Left pincer of a mud shrimp, about twice natural size (*Late Cretaceous*)

A living mud shrimp, *Callianassa*, from the Atlantic Coast. Much enlarged.

Aeger (below), a shrimp about five inches long. Found in Germany. (*Late Jurassic*)



Crab, mud shrimps, and a fossil shrimp.

SEA SCORPIONS

Modern scorpions look like tiny lobsters that live on land, not in the sea.

Sea scorpions, or eurypterids (u RIP ter idz), of Paleozoic times generally made their homes where rivers brought fresh water to the salty sea.

Eurypterus itself was about eight inches long.

It had a broad, blunt head and a jointed body that ended in a spike-shaped tail.

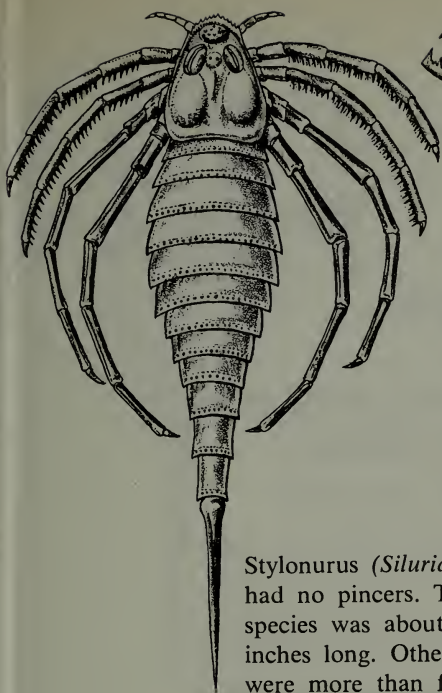
Eight of the ten jointed legs were short, but two legs had become broad paddles with which this animal swam.

Although Eurypterus was not very large, some sea scorpions became giants among the animals which we call invertebrates (in VUR ti brates) because they do not have backbones.

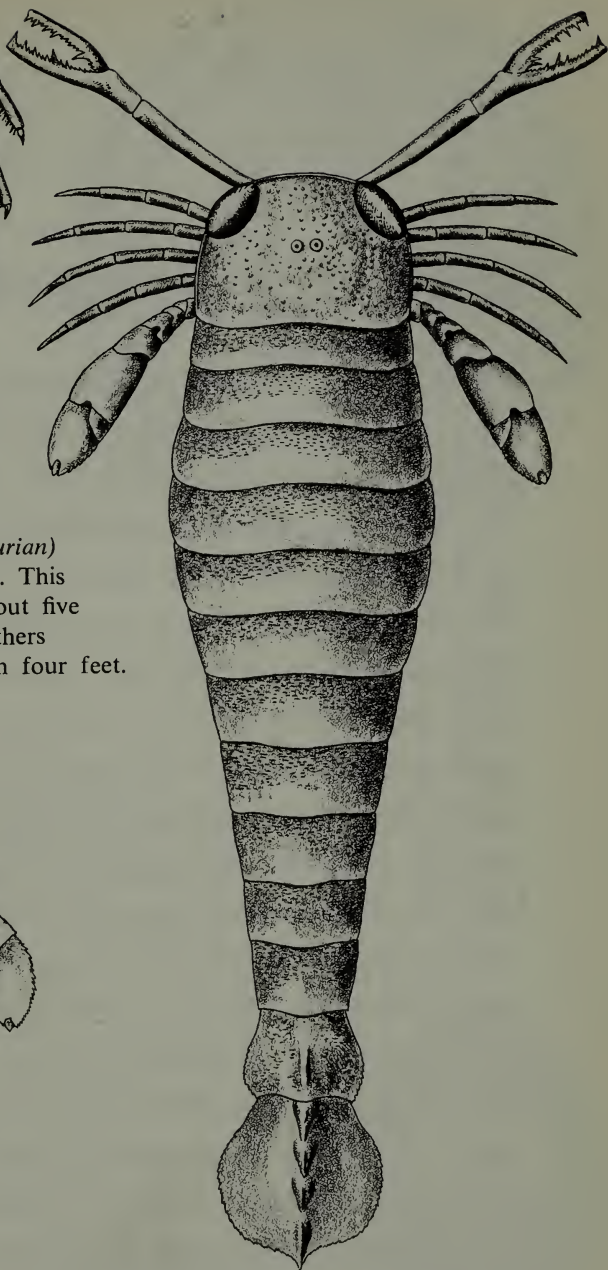
The largest species was six to seven feet long.

It had a blunt tail instead of a spine.

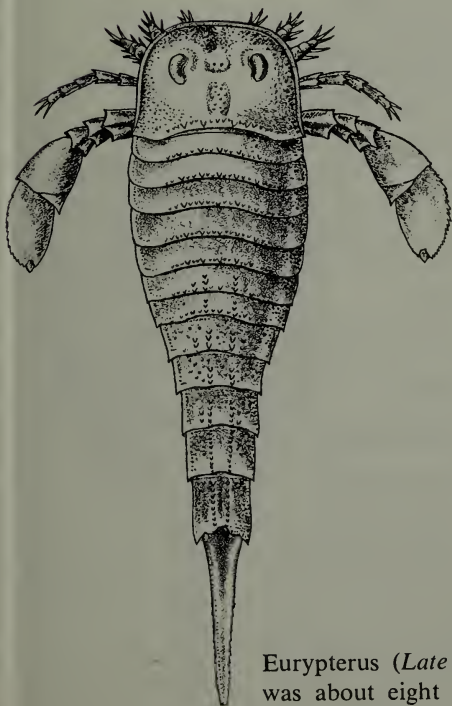
Two legs had become tooth-edged pincers which the animal used to catch food and to fight.



Stylonurus (*Silurian*)
had no pincers. This
species was about five
inches long. Others
were more than four feet.



Pterygotus (*Late Silurian*). This creature
became six to seven feet long and was the
largest of all sea scorpions.



Eurypterus (*Late Silurian*)
was about eight inches long.

Three sea scorpions, or eurypterids.

SOME "LIVING FOSSILS"

Horseshoe crabs are now found along sandy shores from eastern Canada to the Gulf of Mexico.

These creatures are not real crabs, of course, for they have no pincers, and their bodies end in long, slender tail spines.

Horseshoe "crabs" belong to a group of animals that existed long before real crabs became common.

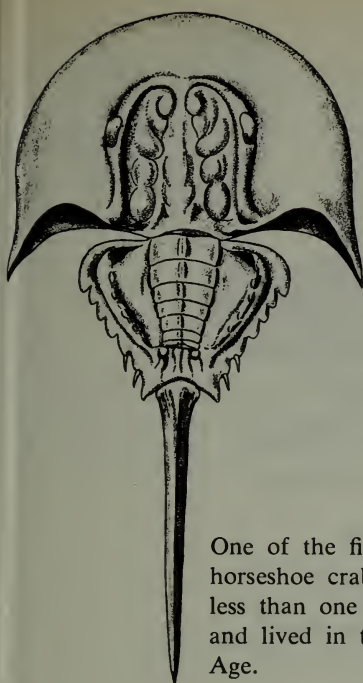
The oldest members of this ancient group looked like trilobites with spines for tails and eleven body-sections behind their heads.

As ages went by, those sections combined into two main parts besides the tail spine.

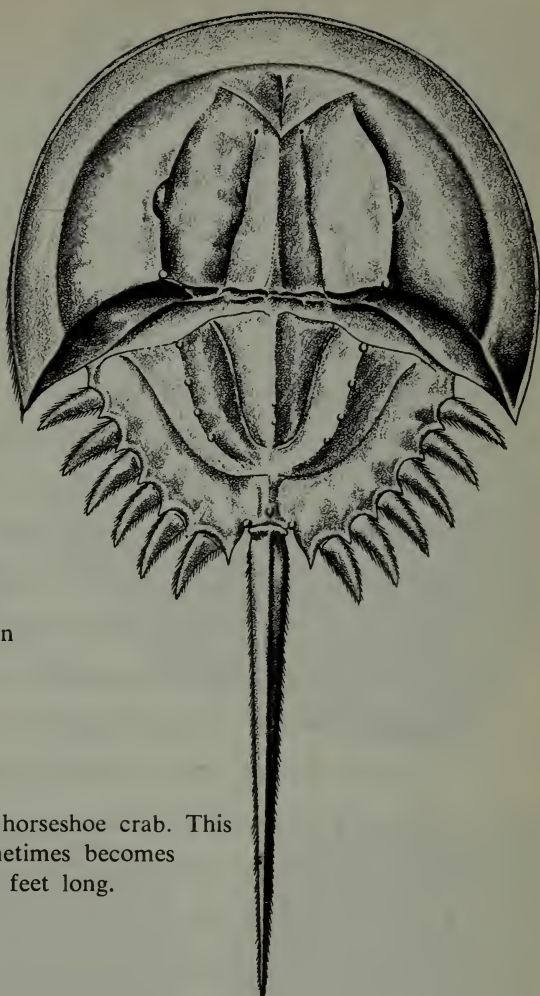
At last, during the Permian Age, some of these creatures turned into horseshoe crabs that were less than an inch in length.

Since that time, horseshoe crabs have grown larger, but their bodies have hardly changed.

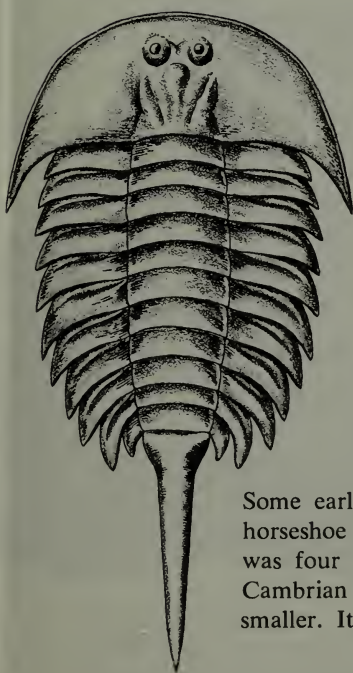
We often call these creatures "living fossils" because they are so much like their relatives that lived more than 220 million years ago.



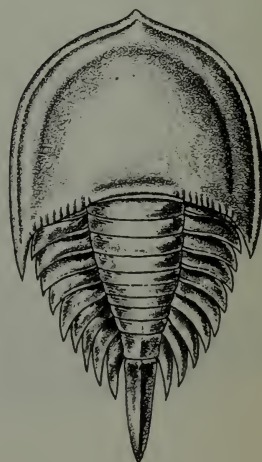
One of the first real horseshoe crabs. It was less than one inch long, and lived in the Permian Age.



A modern horseshoe crab. This species sometimes becomes almost two feet long.



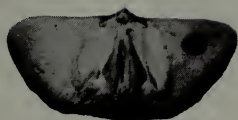
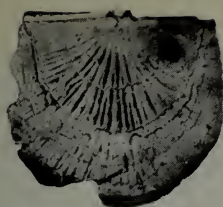
Some early members of the group to which horseshoe "crabs" belong. *Aglaspis* (left) was four inches long and lived late in the Cambrian Age. *Pseudoniscus* (right) was smaller. It is found in Silurian rocks.



Horseshoe crabs and some of their relatives.

TRACKS, TRAILS, AND BORINGS

Many fossils are tracks, trails, or borings made by animals that lived in prehistoric seas. Some of these creatures may have been worms that crawled over soft, wet sand or mud. Other trails were made by snails that crept on sea bottoms or crawled through loose sand. Trilobites often made tracks, too, for their jointed legs dug into muddy bottoms when the creatures crawled against currents. Tracks consisting of small, sharp marks were made by horseshoe crabs and their relatives as they half-walked and half-swam under water. Small holes in petrified clams and brachiopods were made by snails that bored through shells in order to eat the creatures inside them. No one knows what made many other trails. They are puzzles which you may solve some day by finding animals that make similar marks in mud or sand near modern shores.



These holes are not trails; they were made by snails that bored into lamp-shells and ate their flesh.

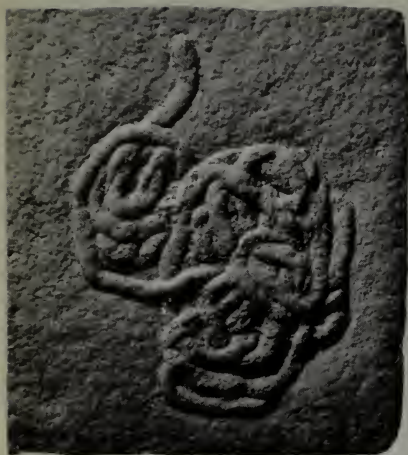


Some trails on the hardened mud at the right may have been made by worms.



This trail was made by a snail that crawled under loose sand. The sharp marks at the right were made by a relative of the horseshoe crab.

Tracks, trails, and borings.



Lumbricaria, a hardened casting (*Late Jurassic*)



Arthropycus is filled burrows of worms that ate their way through sandy mud. (*Silurian*)

CASTINGS AND BURROWS

When earthworms burrow they swallow soil
and digest tiny plants and animals that live in it.

The worms then get rid of the soil
by squeezing it out in little coiled piles
which we often see on the ground.

Some ancient sea worms swallowed mud, not soil,
and squeezed it out in coiled "castings"
that hardened and became fossils.

Other worms ate their way through muddy sand
and filled their burrows with their castings.

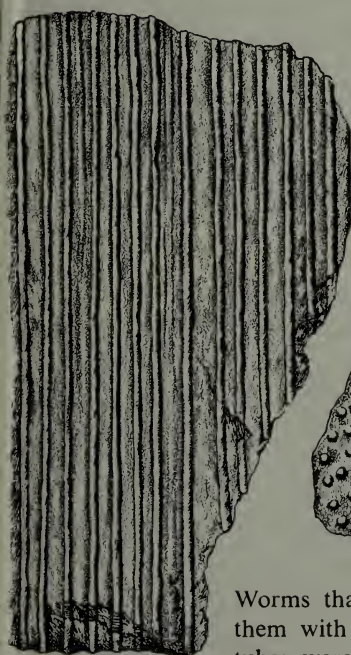
These were once supposed to be fossil seaweeds,
and were called Arthropycus (ARE throw FY kus),
a name that means "jointed sea-plant."

Still other ancient worms lined their burrows with tough tubes that were almost straight or were bent like the letter U.

When the worms died, sand filled the tubes, and slowly became sandstone.

Curved marks or ridges in the sandstone show us that U-shaped burrows were dug deeper and deeper as the worms inside them grew.

These fossil castings, burrows, and filled tubes have been named, though no one has found remains of the sea worms that made them ages ago.



Side view
of *Scolithus*
(Cambrian)

Top of *Scolithus*



Diplocraterion
(Cambrian)



Worms that made these burrows lined them with tough tubes. In time, the tubes were filled with sand which has become sandstone.

Straight and U-shaped burrows. Both were lined with tubes.

BRYOZOANS, OR MOSS-ANIMALS

The name bryozoan (BRY o ZO un) was made from two Greek words that mean "moss-animal." Some living bryozoans do look like brownish moss, though others resemble lace, petrified plants, or stony corals with thousands of tiny holes scattered over their surfaces.

But "look like" and "resemble" do not mean much, for bryozoans are a special group of animals that live together and build tubelike supports for their tiny, soft bodies.

If you look at bryozoans through a microscope you will see that one animal lives in each tube.

This animal has a very short body, with wriggly arms that capture food and a mouth that swallows it.

Ancient bryozoans had all these things, too, but only the tubes could be petrified.

They form chains, nets, and branched stalks, as well as big, stony fossils.



Lyropora (Mississippian)



Monticulipora (Ordovician)



Amplexopora (Ordovician)



Constellaria (Ordovician)



Hallopora (Ordovician)

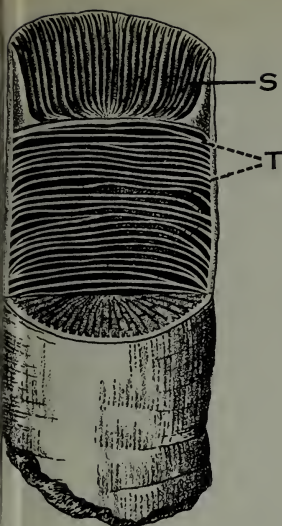


Batostoma (Ordovician)

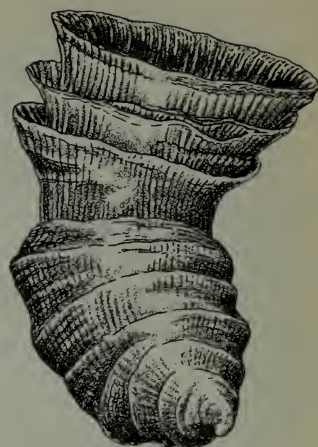
Some moss-animals, or bryozoans.

HORN, OR RUGOSE, CORALS

People sometimes speak of corals as “insects,” but they really are sea-dwelling creatures that have simple bodies and catch food with soft arms called tentacles (TEN ta kulz). Most corals build hard, strong supports which keep their bodies out of the mud. The first supports were small cones with ridges to which the coral bodies were fastened. But as ages passed, many cones became horn-shaped. They also were covered with irregular coats, which show why horn corals also are called the Rugosa (roo GO sa), or “wrinkled ones.” Ridges on the horns became thin partitions, and curved plates, like floors, were built under the growing bodies. One picture on page 85 shows these structures, but others show a cone-shaped support and horns. Two of the horns have bodies that look as they did when the animals were alive.



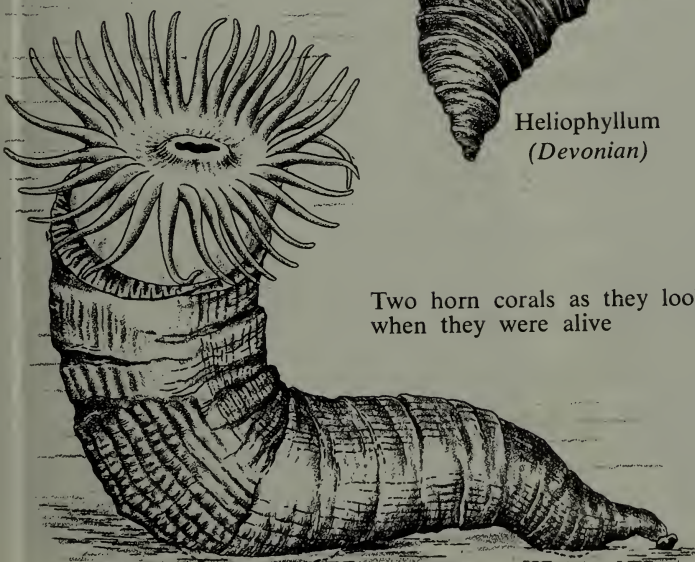
Streptelasma, an early cone
(Ordovician)



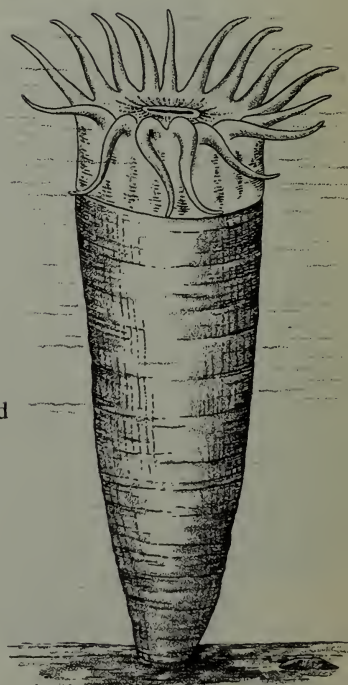
Blothrophyllum, a very
irregular horn coral
(Devonian)



Heliophyllum
(Devonian)



Two horn corals as they looked
when they were alive



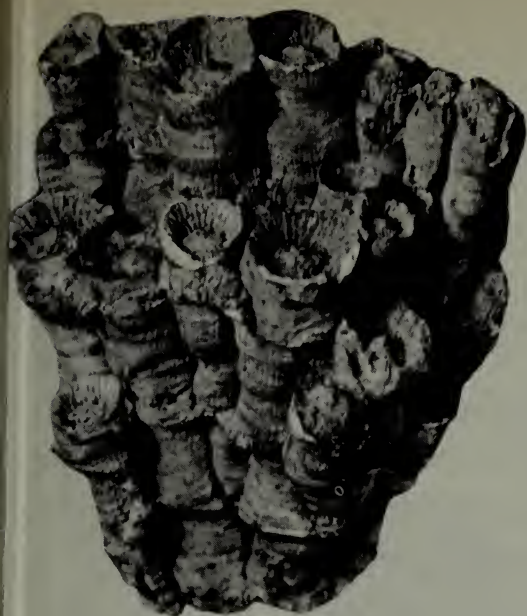
Caninia (Pennsylvanian) often fell on its
side, but it soon grew upward again.

This Streptelasma (Ordovician)
stood with its tip sunk into firm mud.

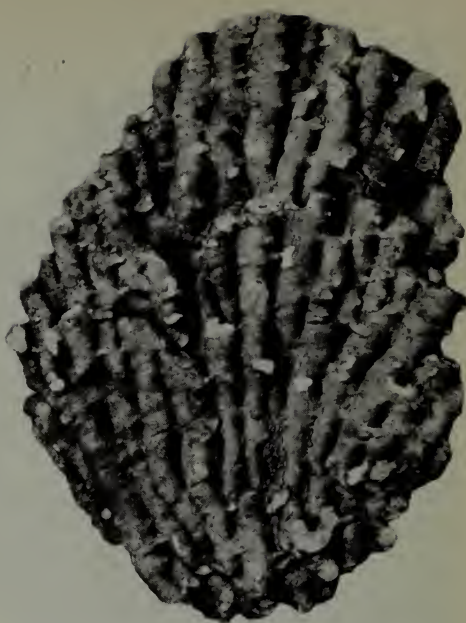
Simple horn-shaped, or rugose, corals.

FROM HORNS TO CORAL HEADS

The first rugose corals lived alone,
but as ages went by some kinds divided
into two, four, or perhaps eight animals
whose horns were fastened together.
Other kinds divided still more, building "heads"
that contained dozens or even hundreds of supports,
which are called corallites (KORE uh lites).
In some heads, the corallites branched
almost like stems and twigs in bushes.
Other corallites were crowded together,
but each one kept its own wrinkled coat.
In other species, the corallites were crowded
so closely that they held onto each other
and grew in five- or six-sided shapes.
Many corallites even ran together, with no coats
or walls to show where one stony support ended
and the corallites next to it began.
We call all these corals compound because
many animals built up each colony, or head.



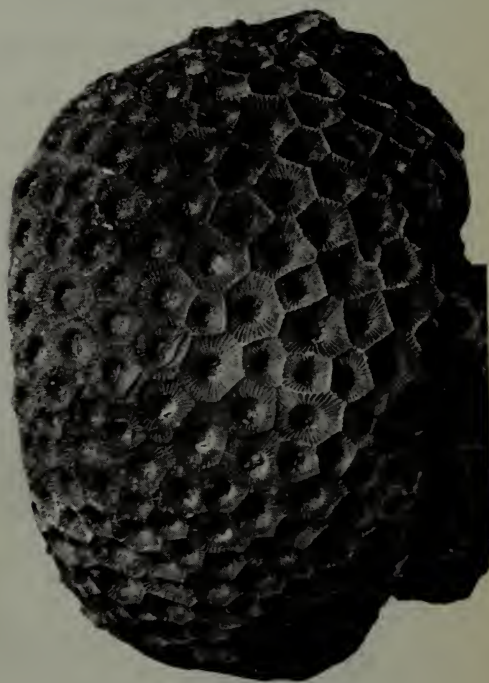
Corals that built this "head" grew side by side. *Lithostrotionella* (*Mississippian*)



These corallites branch almost like a bush. *Entelophyllum* (*Silurian*)



These corallites run together, with no walls to separate them.



A "head" made by closely crowded corallites. *Hexagonaria* (*Devonian*)

Rugose corals that grew in colonies.

HONEYCOMB CORALS AND CHAINS

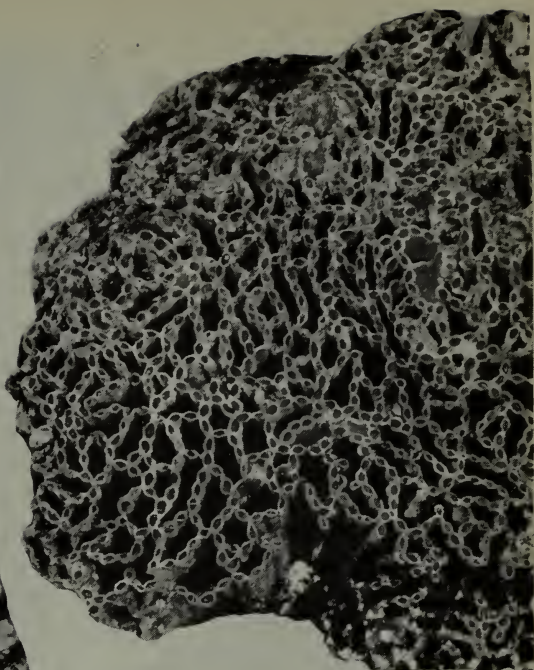
“Petrified honeycombs” are common in rocks that formed during the Silurian and Devonian Ages. These fossils belong to a group of compound corals called tabulates because many kinds contain flat cross-partitions, or tabulae (TAB u lee), which divide the corallites into sections that look like the box-shaped cells in honeycombs. Many tabulate corals built dome-shaped masses, but others spread out like irregular cakes. In still other kinds, the colonies branched, but some kinds spread over shells and corals or even grew upon hardened mud. Chain corals grew side by side, building rows of corallites that resemble chains when we look down upon them. Chain corals are not so common as honeycombs, but good specimens may be found in many rocks of Silurian age.



Emmonsia, a honeycomb coral with spines, not septa (*Devonian*)



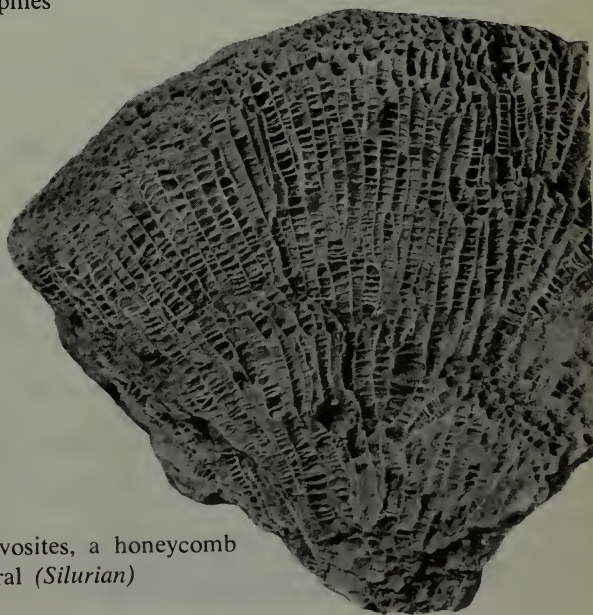
Enlarged photograph showing spines



Upper surface of a chain coral, *Catenipora* (*Silurian*)



Upper surface



Favosites, a honeycomb coral (*Silurian*)

Broken "head" showing septa.

Fossil "honeycombs" and "chains" are tabulate corals.



Septastrea
(Pliocene)



Haimesiaster
(Eocene)



Archohelia
(Oligocene)

Three corals of Tertiary age.

NEW TYPES OF CORALS

Rugose corals were common for 200 million years, but they died out, or became extinct (ex TINGT), at the end of the Paleozoic Era.

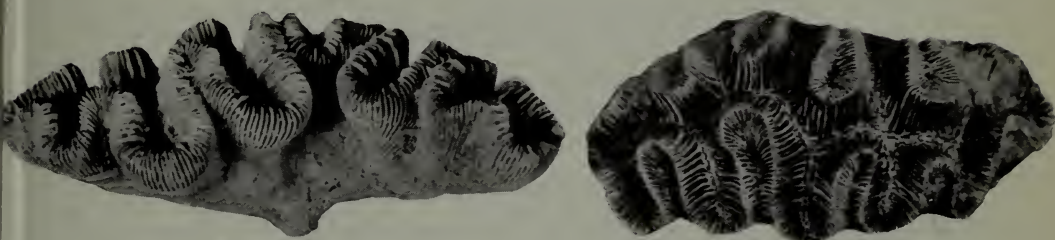
Tabulates lived a good deal longer,

but they also died out during the Jurassic Age.

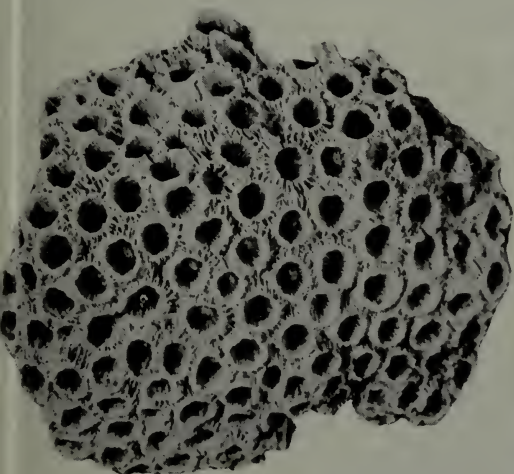
When that happened, new types of corals developed, especially in warm, or tropical, seas.

Some of these new corals were horn-shaped and lived alone, like most horn corals.

Other kinds built colonies that branched, or spread out like stony mushrooms, or formed rough, dome-shaped colonies that sometimes looked like huge brains. Where millions of these corals lived in one place they built reefs that often became islands. Coral reefs that began in Tertiary times are still forming in tropical seas. Fossil reefs of Tertiary age have also been found in Europe, Asia, California, and Alaska.



Maeandra (Pleistocene-Recent). A colony of corals lived together on this stony support. This species still lives near Florida.



Orbicella (Pleistocene)

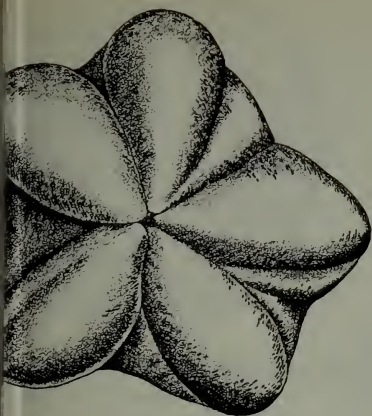


Aulopora, enlarged three times (*Devonian*)

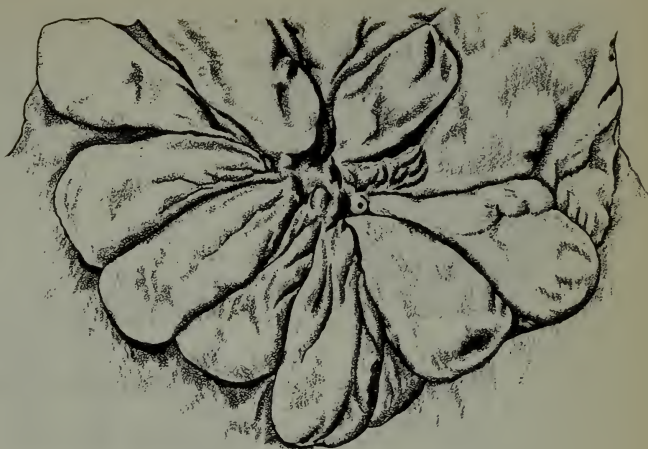
Three new-type corals and a small tabulate that grew on solid mud of the sea bottom.

JELLYFISH

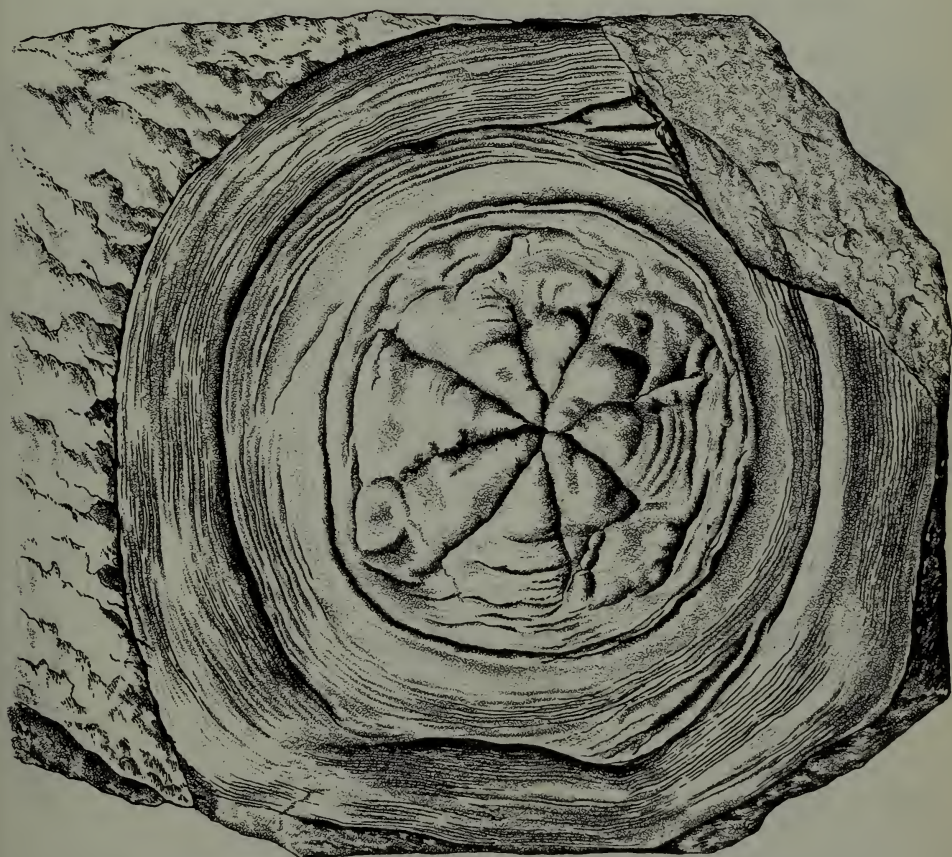
Jellyfish are soft-bodied relatives of corals, and most of them float or swim in the sea. When we watch jellyfish swim, they seem too soft and much too watery ever to become fossils. But when a jellyfish is washed onto a beach the soft body dries out and becomes so tough that it often lasts until it is covered with sand. Ancient jellyfish also were washed onto beaches, where their dried bodies left impressions in beds of mud or sand which hardened into stone. Some impressions are almost a billion years old. They were made by creatures quite different from jellyfish that are living today. Other impressions are not nearly so old nor so different from modern species. Some, in fact, are related to big pink jellyfish that are common in present-day oceans and are often washed onto shores.



Brooksella, from Alabama
(*Cambrian*)



This impression of a jellyfish, from Arizona,
is almost a billion years old. (*Precambrian*)



Rhizostomites, a big jellyfish found in Germany (*Jurassic*)

Three fossil jellyfish.

FOSSIL SPONGES

Most modern sponges are soft-bodied creatures that disappear soon after they die.

Some ancient sponges also were soft, but other kinds stiffened themselves with glassy or stony material which lasted so long that the creatures often became fossils.

Many fossil glass sponges are shaped like vases with knobs and ridges on their sides.

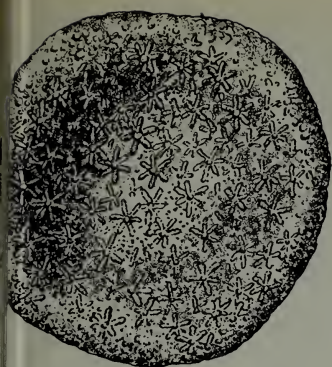
Some stony sponges are vase-shaped, too, but others resemble mushrooms, cups, carrots, or balls which have been hollowed out at the top.

Still other fossil sponges are saucer-shaped.

They contain six-pointed stars of flinty material which are known as spicules (SPIK yoolz).

Both balls and saucers sometimes lie on the ground where beds of limestone have been worn away.

These fossils, which are often bright brown, make fine specimens for collections.



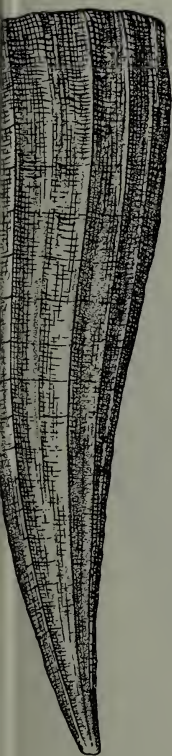
Astraeospongia, a saucer-shaped sponge with six-sided spicules (*Silurian*)



Palaeomanon, a cup-shaped sponge (*Devonian*)



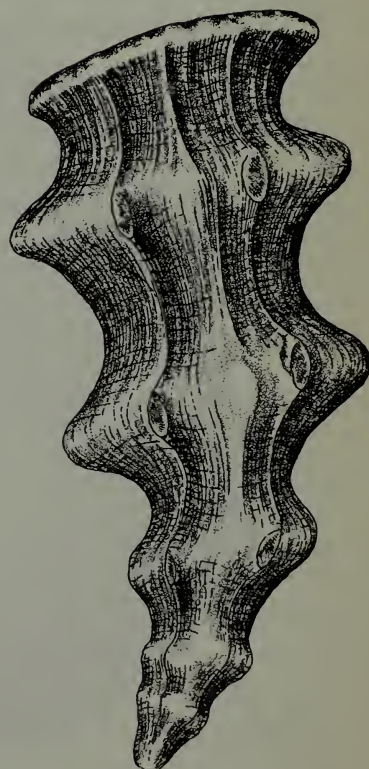
Astylospongia was ball-shaped but hollowed at the top. (*Silurian*)



Prismodictya, a glass sponge (*Devonian*)



Zittellella was carrot-shaped. (*Ordovician*)



Hydnoceras, another glass sponge (*Devonian*)

Six fossil sponges.

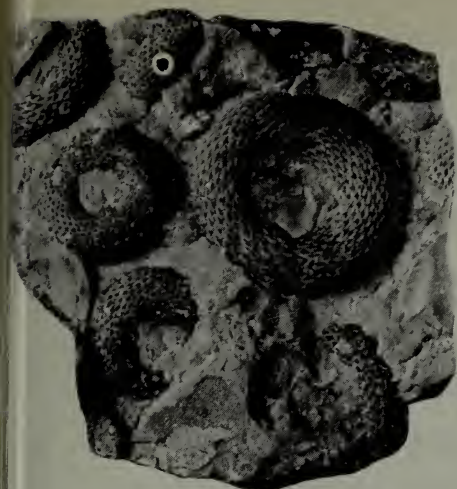
BORERS AND "SUNFLOWER CORALS"

Modern boring sponges are yellowish creatures
that cover shells and grow into them,
filling them with tube-shaped holes.

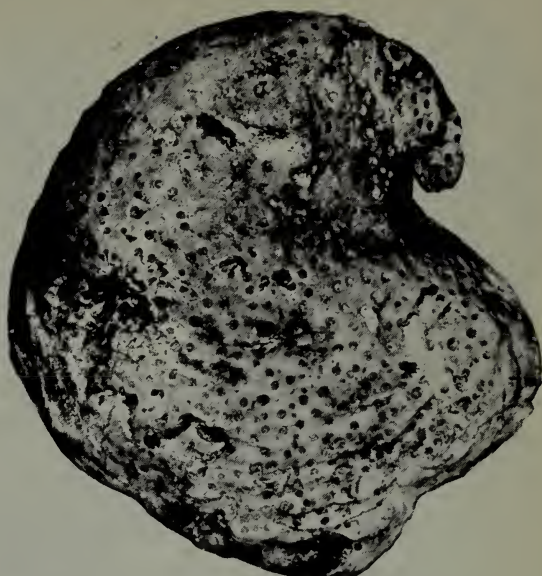
Many ancient sponges also were borers,
for they made holes which we find in corals,
snails, lamp-shells, and the coiled shells related to oysters
that are shown on pages 28 and 29.



These ancient borers probably looked and lived
like modern boring sponges,
but the fossils known as sunflower corals
are different from anything that is living today.
They are not corals, in spite of their name,
for they seem to be sponges with big spicules
which are set close together, like sunflower seeds.
Some kinds became one foot to two feet wide.
Others measure less than two inches,
but they grew so thickly that their fossils
almost fill beds of stone.



Ischadites, a small "sunflower coral," almost fills this limestone. (*Ordovician*)



A shell full of holes made by *Cliona*, a boring sponge. (*Cretaceous*)

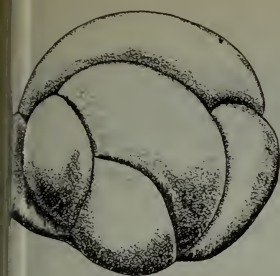


Receptaculites, the big "sunflower coral," seems to be a sponge. (*Ordovician*)

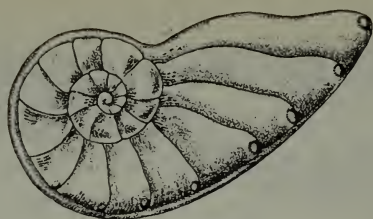
Sponge borings and two "sunflower corals."

SIMPLE “FORAMS”

The creatures shown on page 99 are named Foraminifera (FO ram i NIF er uh), but we call them “forams” (FO rams) for short. Although these creatures have a long name, only a few grow as large as a dime, and most kinds are so small we must look at them through a microscope if we want to see them clearly. Forams also are simple, for each one consists of a single cell which is not divided into parts such as skin, mouth, stomach, and arms. When a foram is hungry, its soft flesh flows out of holes in the shell and forms “false feet” which catch food and digest it. One picture on page 99 shows a living foram whose false feet have caught some tiny plants and are digesting them outside the shell. Other pictures show some of the best-known species of fossil Foraminifera.



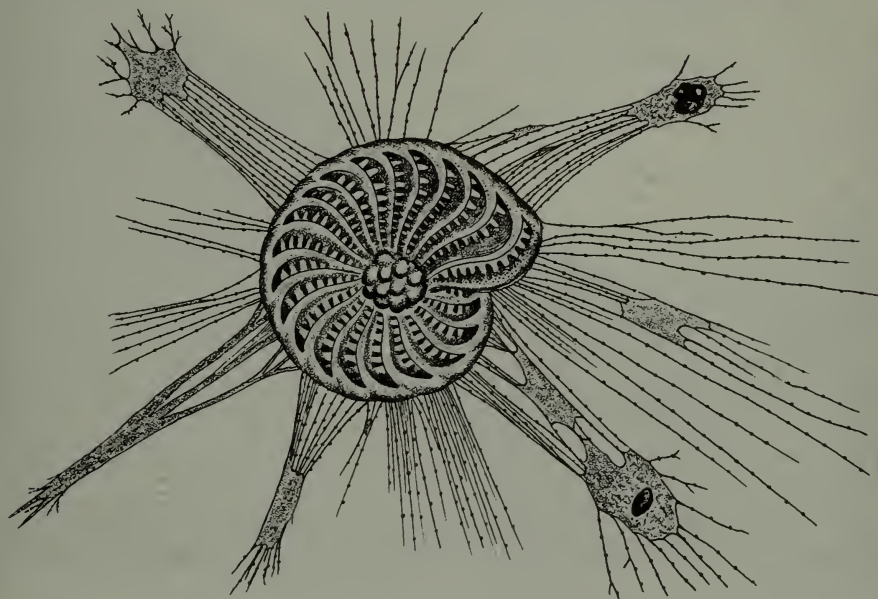
Globivalvulina
(Pennsylvanian)



Planularia (Eocene)



Virgulina
(Miocene)



Polystomella, a living foram, has sent streamers of flesh out of its shell. Some streamers are digesting tiny plants.



Orthovertella (Pennsylvanian)

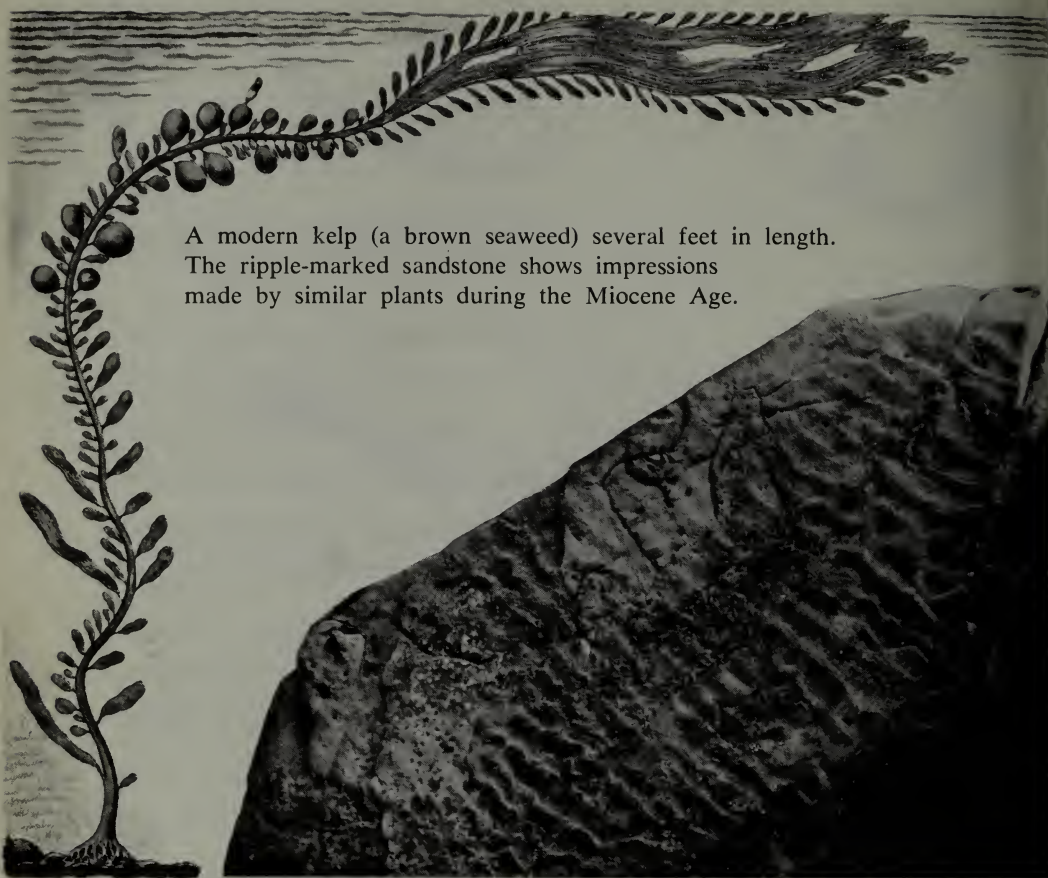


Camerina, or "Nummulites"
(Eocene)



Textularia
(Eocene)

Some typical "forams," many times life-size.



A modern kelp (a brown seaweed) several feet in length. The ripple-marked sandstone shows impressions made by similar plants during the Miocene Age.

SEAWEEDS AND STONY ALGAE

Modern seaweeds are often found on beaches, but prehistoric seaweeds are rare.

Some are thin, dark marks on layers of shale—marks that seem to be leaflike “blades” or stems.

Other fossils are impressions which brown seaweeds called kelp left in beds of sandstone.

Most fossil sea plants, however, are algae (AL jee) that covered themselves with stony material while they were alive.

These stony algae often grew in thick beds or built up reefs that ranged from small domes to broad "barriers" hundreds of miles in length. Some reefs are more than a billion years old, but others are still being built in warm, or tropical, seas.



Stony sea plants called *Cryptozoon* in a great barrier reef near Saratoga Springs, New York. (*Late Cambrian*)

HOW MUCH DO THEY SHOW?

Most of the fossils we have examined
are shells, skin-crusts, plates, and spines,
or stony supports built by corals and bryozoans.
These fossils show the shapes of ancient creatures
and tell many facts about their bodies.
Clam shells, for example, show marks made by muscles,
as well as lines left by soft tubes
through which the clams got water and food.
Lamp-shells show muscle "scars," too,
as well as channels where watery blood
flowed through the soft, thin bodies.
Other fossils show skin and even flesh
which decayed so slowly that they became
thin sheets of the black material called carbon.
Some of these carbonized fossils are worms,
but others are jellyfish, little lamp-shells,
and jointed animals related to trilobites.
A few are even big sea-going reptiles
like the fish-lizard shown on page 115.



The soft body and legs of this wormlike creature were preserved in mud that became black shale. The fossil is a thin layer of carbon. (*Cambrian*)



This fossil shows the shape of a small animal and some of its internal organs. (*Cambrian*)

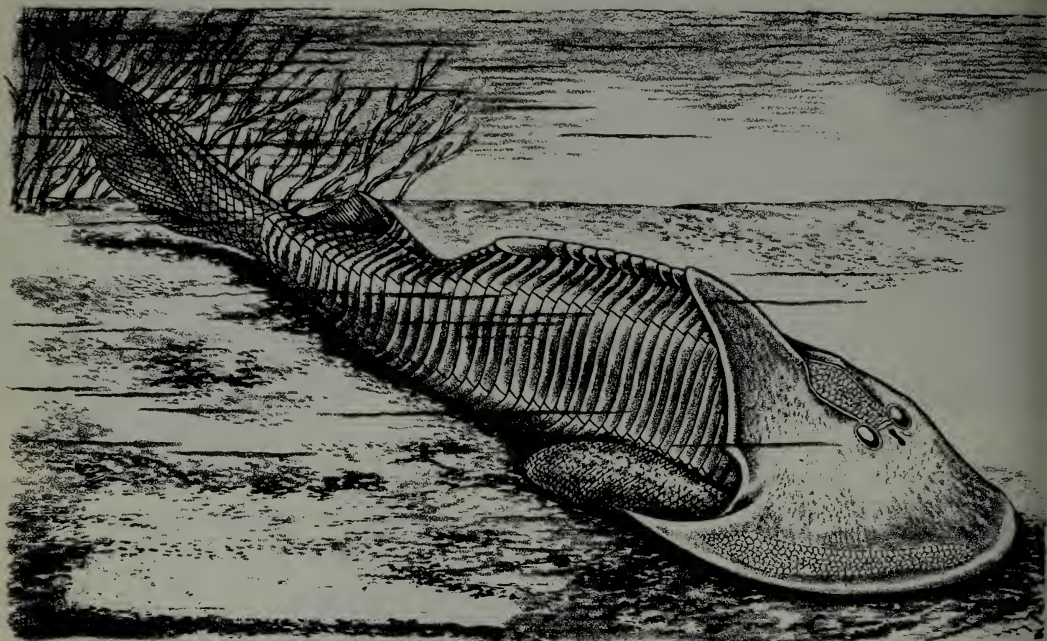


The inside of this lamp-shell shows marks made by muscles, blood vessels, and other soft parts of the body. (*Devonian*)



Two small, soft-bodied creatures that were related to trilobites. The one at the right shows the stomach and intestine. (*Cambrian*)

These fossils tell about the bodies of five ancient animals.



Cephalaspis, a large-headed ostracoderm about seven inches long (*Devonian*)

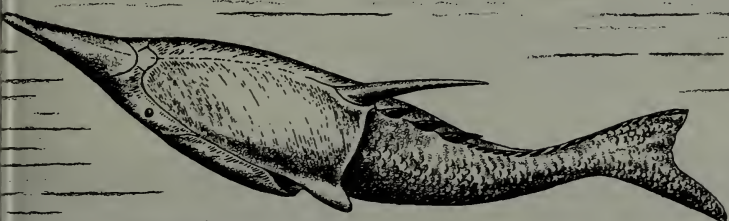
FISH WITHOUT JAWS

People often go to the shore to catch fish, yet fish have not always been common in seas, and they have not always resembled the fish that are caught today.

The earliest fish were little creatures that had no jaws and no fins that grew in pairs. We call these fish ostracoderms (os TRAK o durmz), a name that means “bony skins.”

Some ostracoderms had slender bodies that were covered with bony scales and plates.

Other ostracoderms were broad and flat.
Still others had broad shields on their heads.
We think these odd fish developed in rivers,
and many kinds never left fresh water.
Others wriggled or swam downstream to the sea
where their bony plates and shields became fossils
in beds of sand that slowly turned into stone.

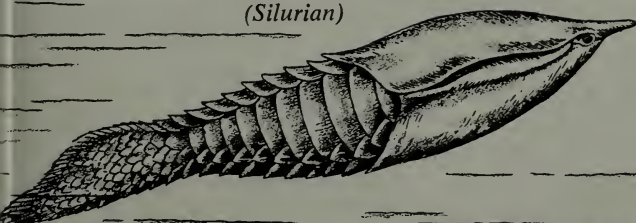


Pteraspis (*Devonian*)

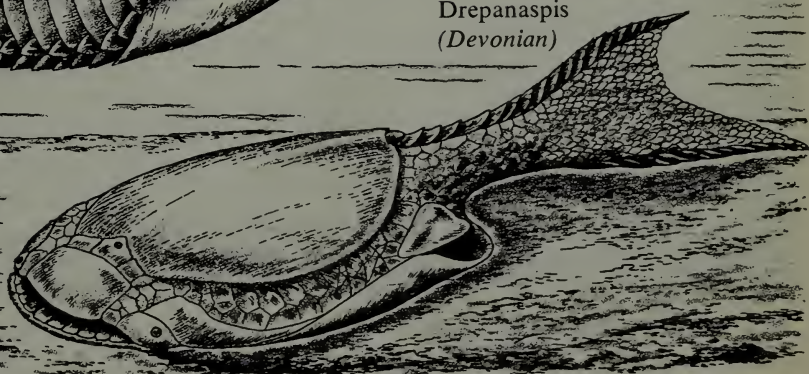


Birkenia
(*Silurian*)

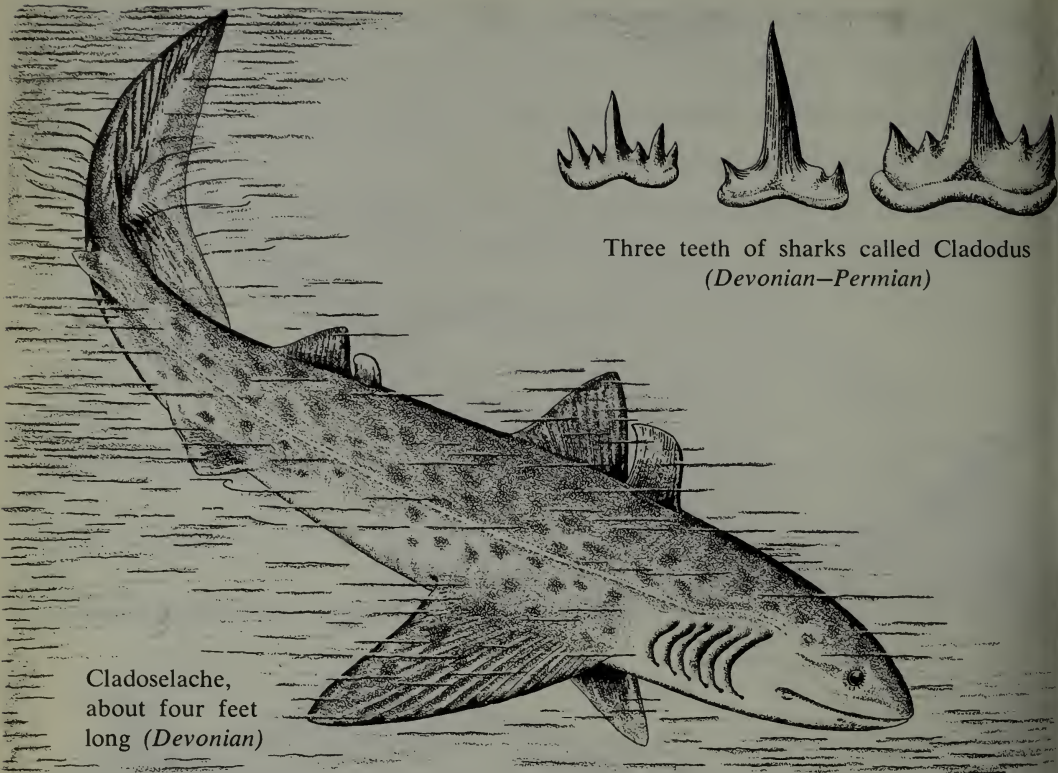
Anglaspis
(*Silurian*)



Drepanaspis
(*Devonian*)



Four bony-skinned ostracoderms that lived in fresh water.



An early, primitive shark and some fossil teeth.

SHARKS AND SHARK TEETH

This ancient type of shark, about four feet long, lived near the end of the Devonian Age.

Sharks are fish with jaws and two pairs of fins, but their skins are not covered with armor.

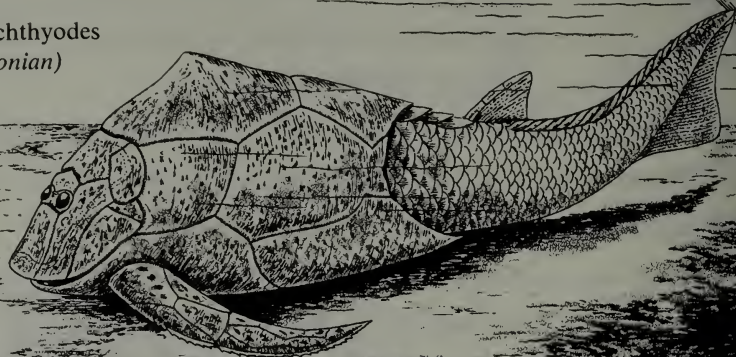
The bones in their bodies also are not hard, but are made of soft white material that is called cartilage (KAR ti lij).

Shark teeth, however, are hard and sharp.
Early sharks' teeth were sometimes petrified,
and when modern types of sharks became common
their teeth often turned into fossils,
though their flesh and the soft bones disappeared.
Some petrified shark teeth have several points,
but others have only one point.
The largest teeth are broad, with sawlike edges.
These teeth belonged to white sharks forty-five feet long
that had jaws six feet or more in width.



Two slender shark teeth (*Pliocene*) and one tooth of a white shark, whose scientific name is *Carcharodon*. (*Miocene*)

Pterichthyodes
(Devonian)



This armored fish had jaws and paired fins covered with bone.

FISH WITH BONY JAWS

The men who first found this ancient creature thought it was a thick-shelled crab.

Instead, it was a small armored fish with bony jaws and a pair of bone-covered fins that looked a bit like wings.

Wing-fish swam in rivers and ponds of Europe during the Devonian Age,

but other fish with jaws and pairs of fins had already gone to live in salt water.

Many of these creatures breathed with lungs, which means that they had to come to the surface and swallow mouthfuls of air.

Some air-breathers soon became true lungfish, related to lungfish that still live in Australia.

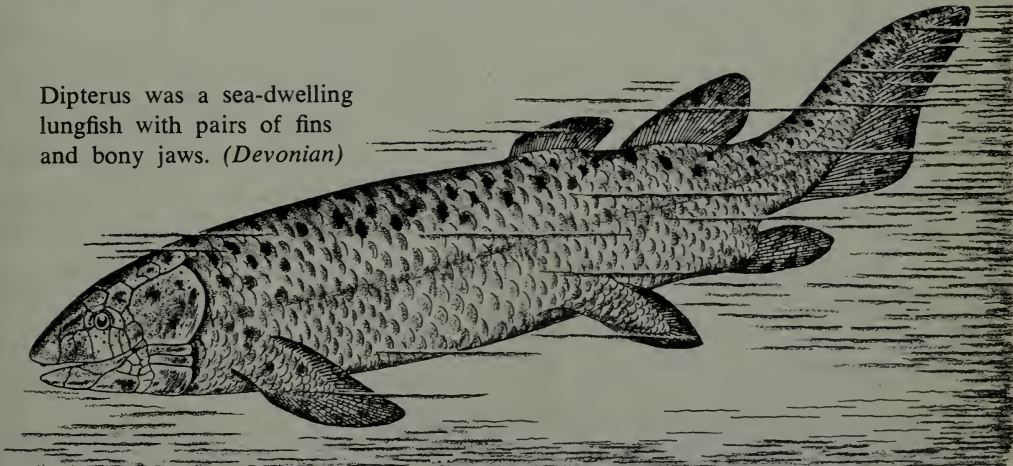
Other air-breathing fish belonged to the group whose only name is coelacanth (SEE la kanths).

They once were supposed to be extinct, but then living coelacanth was caught in the ocean east of Africa.

These fish also may be called living fossils, for they have survived without important changes since the Cretaceous Age ended, seventy million years ago.

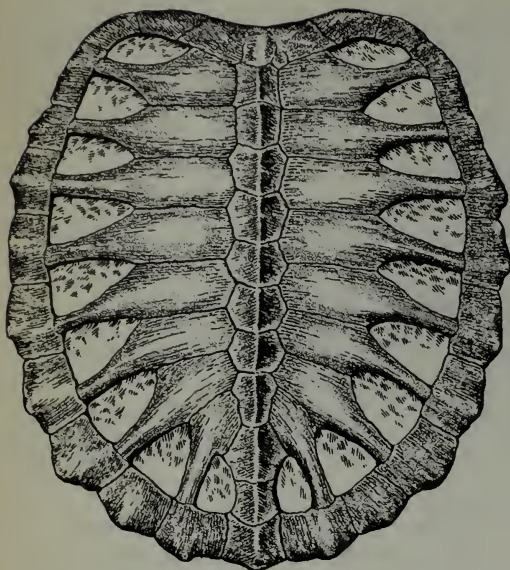


Undina, a marine fish of the group called coelacanth, was about two feet long. (*Jurassic*)



Dipterus was a sea-dwelling lungfish with pairs of fins and bony jaws. (*Devonian*)

Two bony fish as they looked when they were alive.



Shell and bones in the left front flipper of *Toxochelys*, a sea turtle whose shell was about forty inches long. (*Cretaceous*)

BIG SEA TURTLES

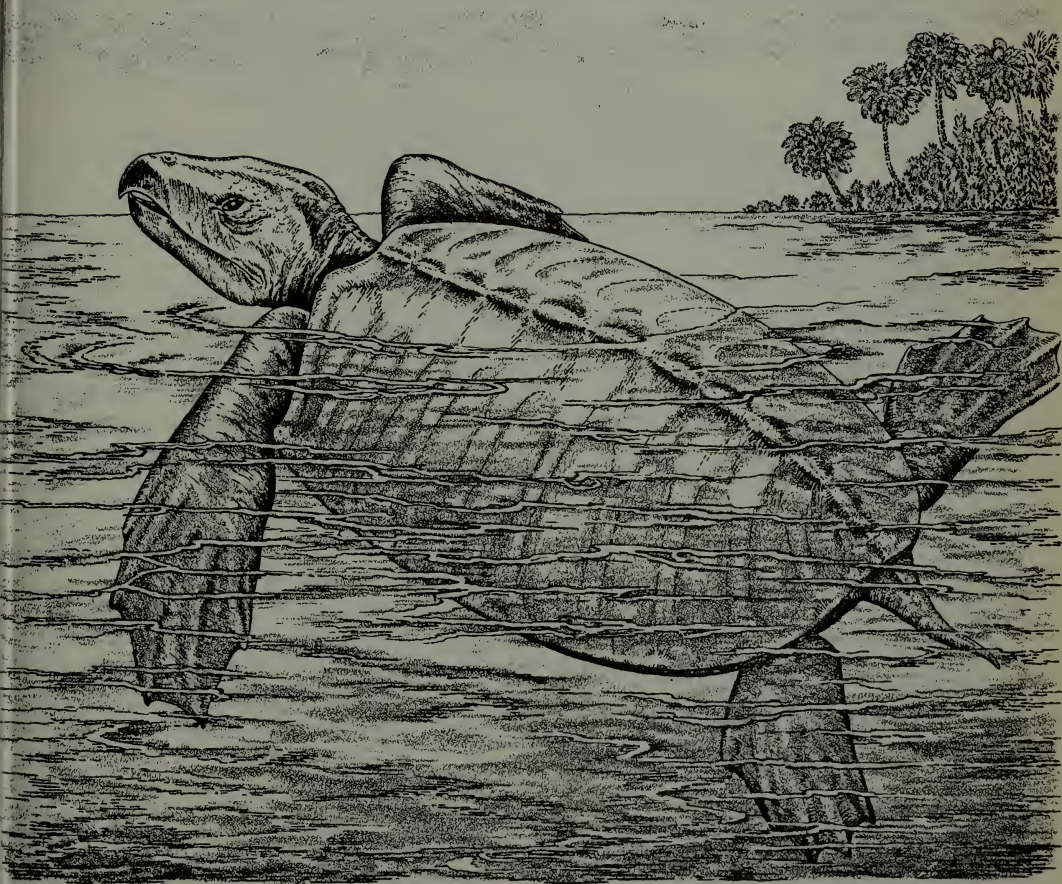
Most turtles that live in rivers are small, and their legs are used for swimming and walking.

Most living sea turtles, however, are large and their legs have turned into finlike flippers with which the turtles swim and crawl.

Ancient sea turtles had flippers, too, and some kinds became giants that were larger than any turtle that is living today.

Largest of all was *Archelon* (AR ke lon), which lived in a sea that covered much of the West late in the Cretaceous Age.

Archelon's leathery shell was twelve feet long, and he probably weighed about three tons. He floated or swam with his big flippers and crawled awkwardly when he traveled on land. When he was hungry, he hunted fish or young reptiles and caught them with his powerful jaws, which were covered with a sharp, hooked beak. Archelon could cut a six-foot fish in two with a single snap of his jaws.



Archelon, twelve feet long, was the largest of all sea turtles.



The oldest crocodile known, about thirty inches long. (*Triassic*)

SEA-GOING CROCODILES

The first crocodiles lived among swampy forests in the region now called Arizona.

The reptiles had armor on the back and underside, and were about thirty inches long.

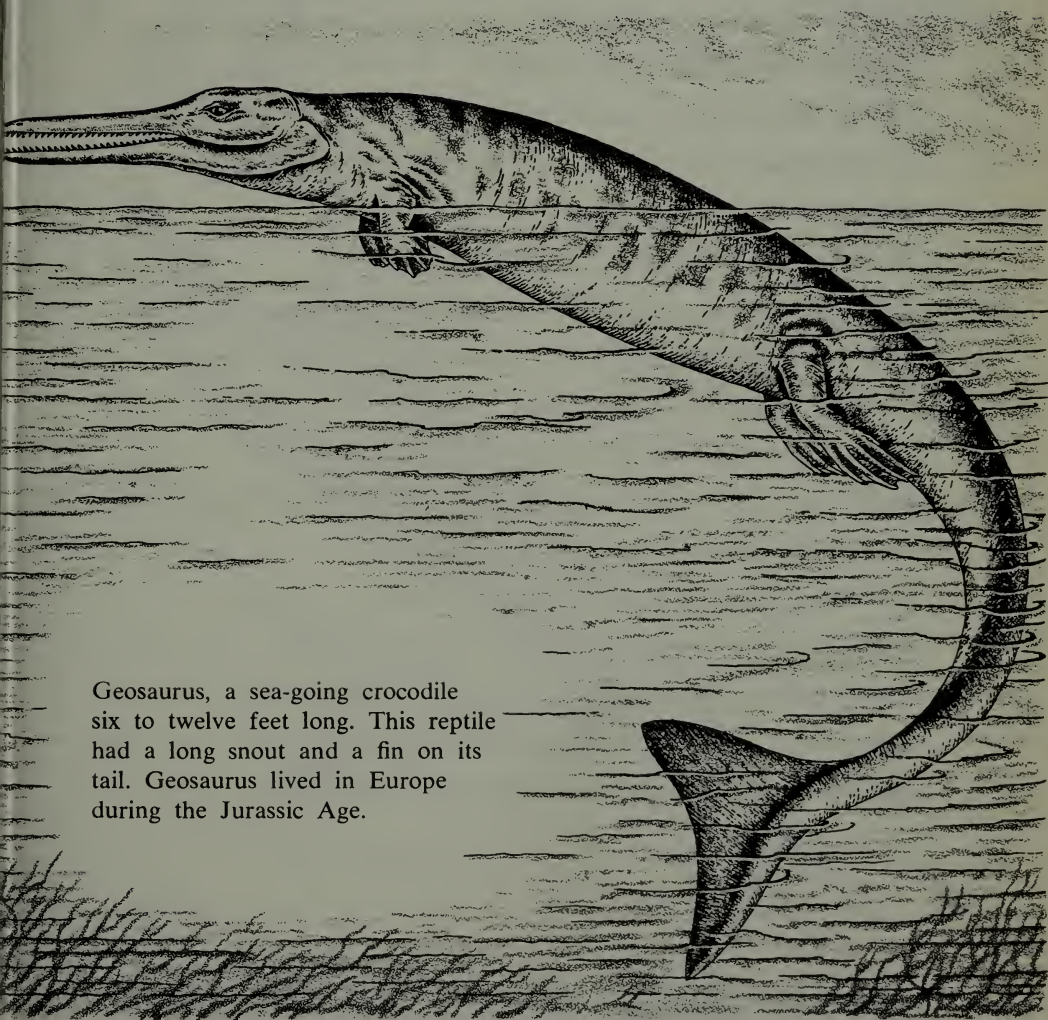
As time passed, however, crocodiles became larger.

They also left their forests and began to swim in rivers, lakes, and swamps near the shore.

Most species went no farther than that, but others finally left fresh water and began to live in the sea.

One sea-going crocodile has the odd name of *Geosaurus* (JEE o SAW rus), which means "earth-reptile" or "earth-lizard."

Geosaurus was a long-snouted creature that had lost the bony armor on his skin. His legs and feet had turned into paddles and a fin had grown on his long tail. Geosaurus could swim rapidly by swinging his tail, but he wriggled and twisted clumsily when he tried to travel on land.



Geosaurus, a sea-going crocodile six to twelve feet long. This reptile had a long snout and a fin on its tail. Geosaurus lived in Europe during the Jurassic Age.

STREAMLINED FISH-LIZARDS

The name ichthyosaur (IK thi o sawr)
means "fish-lizard," and it describes the shape
of this ancient sea-dweller,
which was a reptile, not a fish.

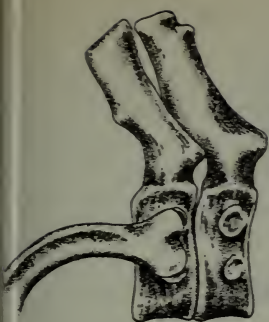
Many fish-lizards once lived in the West,
but others swam in seas that spread across Europe
during the Jurassic Age.

When some European fish-lizards died
their bones were petrified, but flesh and skin
became thin layers of black coal-like carbon
around the petrified bones.

This carbon shows the streamlined bodies
with legs that had turned into fin-shaped flippers
and fleshy fins on the back and tail.

The smooth skin was dark on the back
but it must have been white on the underside.

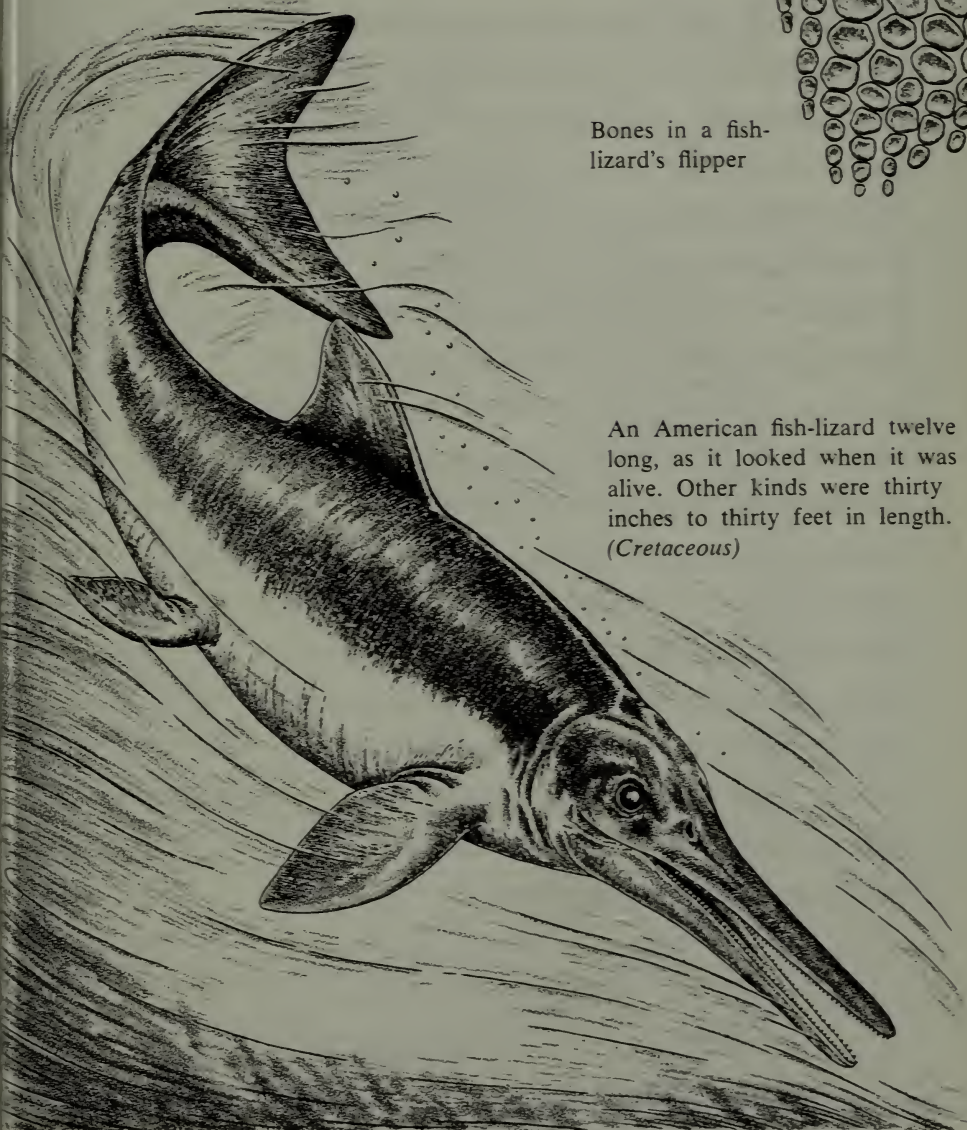
These colors show in the picture of a fish-lizard
as it looked when it was alive and swam
in a sea that once spread across the West.



Vertebrae, or
backbones



Bones in a fish-
lizard's flipper

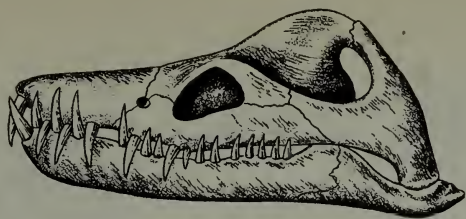


An American fish-lizard twelve feet
long, as it looked when it was
alive. Other kinds were thirty
inches to thirty feet in length.
(Cretaceous)

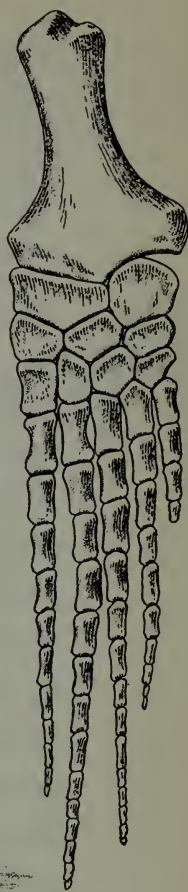
A fish-lizard and some of its bones.

A LONG-NECKED PLESIOSAUR

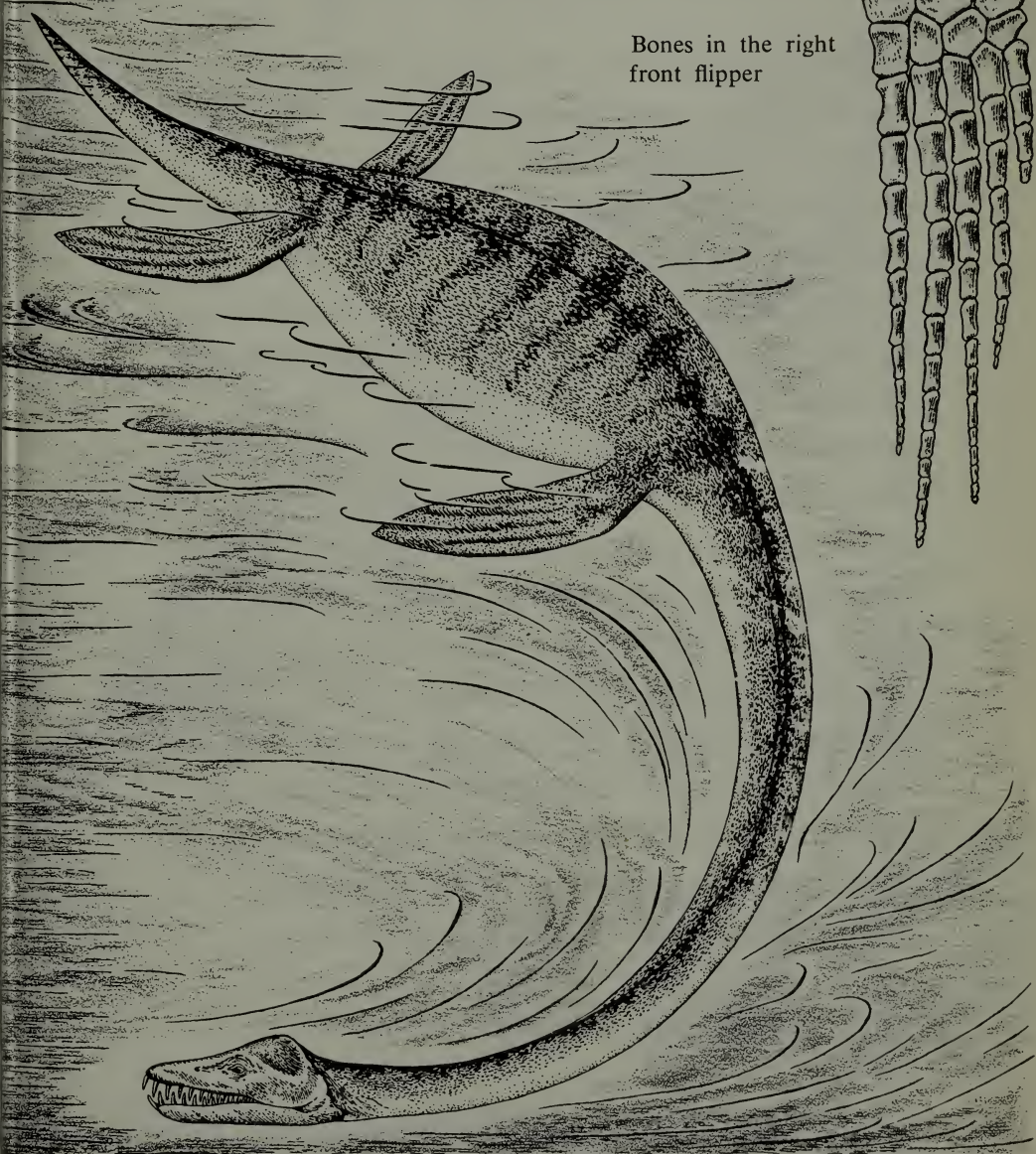
Fish-lizards were smoothly streamlined,
but the plesiosaur (PLEE zi o sawr) on page 117
had a long neck, a broadly flattened body,
and no fins on his back or his stubby tail.
This strange reptile sometimes swam into bays
or swamps along the coast of the sea
in which Archelon and some fish-lizards lived.
But the plesiosaur probably liked open water
far away from islands and from swampy bays.
There he could swim with his oar-shaped flippers,
moving slowly when he was not hungry,
but dashing ahead or diving swiftly
when he wanted to catch belemnites or fish.
He found it easy to reach out and seize food,
for his neck was more than twenty feet long
and his jaws were filled with sharp teeth.
When the plesiosaur snapped up a fish
those teeth held the victim so firmly
that it almost never got away.



Skull



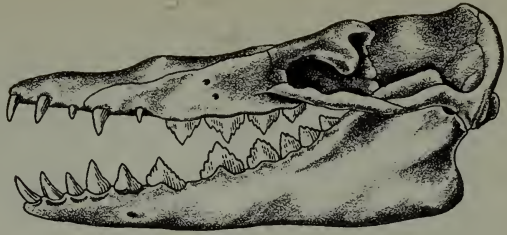
Bones in the right
front flipper



A large plesiosaur, about forty-two feet long. (*Cretaceous*)

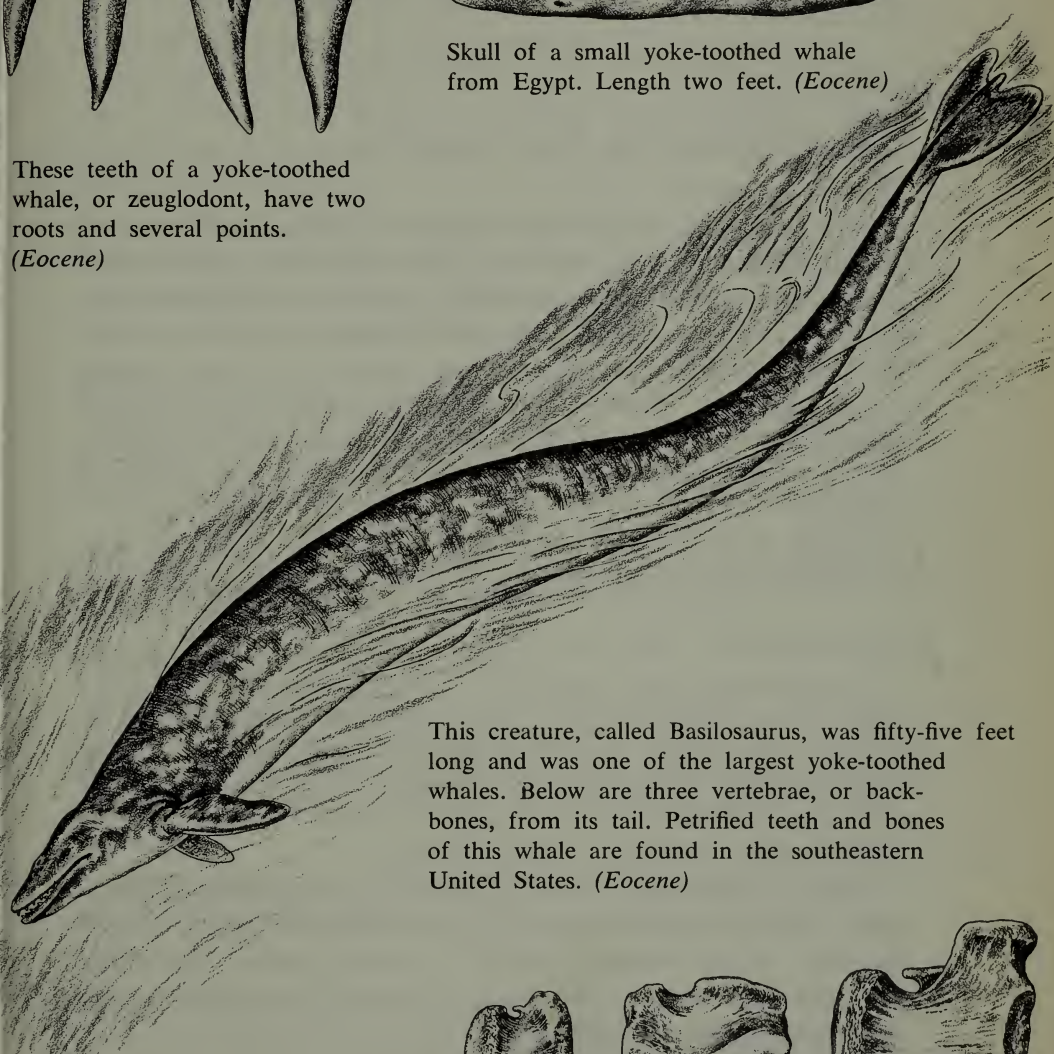
YOKE-TOOTHED WHALES

Whales swim and have streamlined bodies,
but they are neither fish-lizards nor fish.
A whale is a warm-blooded animal,
or mammal (MAM ul), that breathes with lungs
and has a few hairs, not scales, on its skin.
No one knows just when or how whales developed,
but they became common during the Eocene Epoch,
in seas that covered northern Africa
and the southeastern United States.
These Eocene whales had short bodies
and very long, slender tails that contained
thick backbones, or vertebrae (VUR tuh bree).
Some of the teeth had only one root,
but others had two roots and three, four
or even more points, like many shark teeth.
Such “yoke-shaped” teeth give these creatures
both their technical and their popular names.
The former is zeuglodonts (ZOO glo dahnts),
but the popular name is “yoke-toothed whales.”



Skull of a small yoke-toothed whale from Egypt. Length two feet. (*Eocene*)

These teeth of a yoke-toothed whale, or zeuglodont, have two roots and several points.
(*Eocene*)



This creature, called Basilosaurus, was fifty-five feet long and was one of the largest yoke-toothed whales. Below are three vertebrae, or back-bones, from its tail. Petrified teeth and bones of this whale are found in the southeastern United States. (*Eocene*)



Yoke-toothed whales, or zeuglodonts, were common during the Eocene Epoch, which began about fifty-five million years ago.

GREAT GROUPS OF FOSSILS

We have described fossil algae, sponges, trilobites, and so on, up to creatures with hair, warm blood, and backbones. Some of these groups have no relatives; since they stand alone we say they form phyla (FY la), or principal groups, of plants or animals—each group is a phylum. The sponges, for example, form one phylum; lamp-shells form another. But clams do have relatives—snails, horn-shells, ammonoids, belemnoids, and others not described in this book. All these creatures belong together in the phylum of mollusks.

Besides seaweeds and other algae, which are plants, we have examined fossils that belong to nine phyla of the animal kingdom:

PROTOZOANS (PRO toe zo uns)

The protozoan body consists of jellylike flesh which forms a single living structure or cell. These simple creatures are not green and are not plants, so most books put them into the animal kingdom. Their name means “first animals,” and protozoans probably developed long before sponges or corals. “Forams” are the only protozoans that are abundant fossils.

Although most books place protozoans in the animal kingdom, some scientists disagree. They say that protozoans form a separate kingdom whose members should be called protists. Remember this, and don't be surprised if you use one of the books that call these simple creatures protists.

SPONGES, OR PORIFERA (po RIF er uh)

If protozoans are the simplest animals, sponges are the simplest animals whose bodies contain many cells. These cells are arranged in inner and outer layers, with jellylike material between. Cells in the jelly build up the skeleton—the part that becomes a fossil.

Each sponge contains many tiny holes that let water and food into the body, as well as one larger hole through which water goes out again. Although many sponges live alone, others grow in colonies which sometimes become very large.

COELENTERATES (see LEN ter ates)

This phylum includes corals, jellyfish, sea anemones (which have never become fossils), and some other creatures. Their bodies contain an inner and an outer layer, but both may be several cells in thickness. There is a mouth surrounded by tentacles, or arms, and a hollow inside the body. The arms always have stinging cells. Some of these creatures live in fresh water, but most kinds are marine. All fossil corals, jellyfish, and other ancient coelenterates made their homes in the sea.

BRYOZOANS (BRY o zo unz)

All bryozoans live in colonies made up of very small animals that have soft arms, or tentacles, around their mouths. Many modern bryozoans build horny tubes or supports for their bodies, but most fossils were stony even while they were alive. Although bryozoan bodies are small, they contain three layers. So do all other animals that are more complex than coelenterates.

BRACHIOPODS (BRAK i o podz)

Brachiopods have shells with two parts, or valves, which are not alike. The body is surprisingly small, and the mouth lies among tentacles which resemble those of bryozoans. This may mean that these phyla are related, and they were grouped together in many old books.

Brachiopods were abundant during the Paleozoic Era, but not after it ended. Only about 110 kinds, or species, now live in the sea.

ECHINODERMS (ee KY no durmz)

All echinoderms have skeletons that consist of stony spines and plates. Starfish are seen more often than other living echinoderms, though sea urchins are common along sandy seashores. Fossil sea lilies, sea buds, and cystoids are often found in Paleozoic rocks. Sea urchins became plentiful in the Mesozoic Era, and great numbers of them still live in the sea.

MOLLUSKS (MOL usks)

The name of this phylum means "soft ones." All mollusks have soft bodies, but most kinds cover themselves with shells. Most fossil mollusks belong to the following groups:

Snails. The technical name for snails is gastropods (GAS tro podz); it means "stomach-feet." This describes the animals, for most snails crawl on feet which are the flattened underside of the body. Most snails also have coiled shells that contain only one part. Some kinds, however, have shells shaped like broad, shallow cones. Others have lost their shells or have covered them with skin. The commonest fossil snails are kinds whose shells were thick and coiled.

Pelecypods (pe LESS i podz) include clams, oysters, mussels, and their relatives. They have shells made of two parts (valves) that are fastened together with hinges. The soft bodies have no heads, and the feet are generally shaped like wedges or hatchets. In fact, the name pelecypod is made from two Greek words that mean "hatchet-foot."

Cephalopods (SEF a lo PODZ). These are the most highly developed mollusks, for they have eyes and a brainlike mass of nerves in the head. Their feet have become arms that catch food and can also be used for crawling. The shells of horn-shells and ammonoids are straight or coiled. Belemnoids covered their shells with flesh and skin, and octopi (which are very rare as fossils) have no shells at all.

ARTHROPODS (AR thro podz)

The name of this phylum means "jointed feet." Actually, arthropods have joints in their legs, bodies, and feelers, as well as in their feet. Arthropods also are covered with skin-crusts, which are made by the skin and are shed as the animals grow. This phylum includes the crustaceans (crabs, lobsters, barnacles, shrimps, etc.) as well as trilobites, sea scorpions, horseshoe crabs, insects, spiders, centipedes, and millipedes, or "thousand-legged worms." Arthropods that lived on land are rare fossils, but the sea-dwelling trilobites are common.

VERTEBRATES (VUR te brates)

In everyday language, these are animals with vertebrae, or backbones. Actually, many fish do not have backbones—but

they are built like fish that do have bony vertebrae. We therefore put them all in this phylum. Turtles and crocodiles are vertebrates, too, and so were fish-lizards, plesiosaurs, and whales. We may divide these creatures into two groups:

Reptiles (REP tilz) are cold-blooded vertebrates that breathe air. Most reptiles have four legs, though snakes are legless, and several ancient reptiles turned their legs into paddles or flippers.

Mammals (MAM ulz) are vertebrates that have warm blood and hair—even whales have a few hairs on their thick skins. Yoke-toothed whales are the only fossil mammals described in this book.

THE WHY OF STRANGE NAMES

We have described nine great groups of living things, and each group has a name made from Greek or Latin words. Other names of this sort are used for fossils, as well as for most of the eras, ages, and epochs in the Calendar of Ancient Ages on pages 20–21.

Most of these names are strange, or unfamiliar; many of them also are long and seem hard to pronounce. Why, then, do we use them? Why don't we use common English words, which would not be so difficult?

There is one answer to both questions: there are no everyday English names for most groups of plants and animals, most fossils, and most of the divisions in our earth's history. In the days when our language developed, people knew about snails, clams, fish, and whales and gave them English names. But no one knew plesiosaurs, trilobites, the phylum of echinoderms, or the Paleozoic Era. When these things were discovered they had to be named, and the easiest way to get new names was to make them from Greek or Latin words. This also was done when explorers found the Americas or the Pacific Ocean, and when inventors produced locomotives, telephones, automobiles, and electromagnets. Each of these was unknown when the English language first developed, and each one received a name made from Latin or Greek words.

Now and then, of course, we work out English names in place of those taken from Greek or Latin. An automobile becomes a "car," any brachiopod may be called a "lamp-shell," and the Pennsylvanian (this name is half Latin) becomes the Coal Age. We also use "Chalk Age" instead of Cretaceous Age, and call the Pleistocene Epoch the Ice Age. But no one has found an everyday name for trilobites, ostracoderms, or the ammonoid called *Dipoloceras*. And it surely would not make things easy if we tried to call the Paleozoic the "Era of Ancient Animals" or turned plesiosaur into "almost-a-lizard," which is what this name means in English.

Another reason for Greek and Latin is the fact that every kind, or species, must have a name that is different from every other. There are too few English names to go round, but plenty can be made from Greek and Latin, plus some words from other languages. Luckily, you will use very few of these names unless you collect fossils and want to label your specimens. Then you will use such names as Favosites, Solemya, and Ogygopsis, which are printed below the pictures of fossils. Otherwise you may forget these words—unless you want to pronounce them, just because they are hard.

Before you do this, however, suppose you make sure that these words are really hard. Many words seem difficult because they are strange, though they really are no harder than words we see or hear again and again. If you doubt this, write down some of the strange words used in this book. Then match them with everyday words, like this:

trilobite	telephone
brachiopod	bronco buster
Ordovician	organization
ammonoid	ammonia
belemnoid	beautiful
Arthropycus	automobile

Is one list really harder than the other? Or do words in the first list only *seem* to be hard because you have not seen them often and do not use them every day?

INDEX

There are many kinds of fossils, and they have many names. This index gives the technical names of fossils that are described in the text. Other names will be found with illustrations, which show important members of groups that range from seaweeds to animals with backbones.

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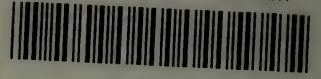
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